
**Thompson River Forest Highway Proposal
Aquatic and Hydrologic Assessment of the
Thompson River Corridor – Road MP 0.0 to 42.6**



**Final Report
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Introduction

In 2003, the Federal Highway Administration, Western Federal Lands Highway Division (WFLHD) joined in partnership with the U.S. Forest Service, U.S. Fish and Wildlife Service, and Montana Fish Wildlife and Parks to assess the potential impacts of the proposed Thompson River Forest Highway alignments on the aquatic and hydrologic resources of the Thompson River. The results of the assessment were to be used for developing the proposed forest highway Environmental Impact Statement and aquatic consultation requirements.

The Federal Highway Administration proposed two possible alignments; the “Preferred” Alignment and the “Secondary” Alignment. The two proposed alignments are variations of the existing dual road system which consists of Route 56 and Route 9991. Figures 2a and 2b depict the proposed alignments relative to the existing road systems.

Figure 1 lists the purpose and objectives of the assessment. Fourteen analyses were conducted to assess existing conditions and potential impacts of the proposed Thompson River Highway alignments on aquatic and hydrologic resources. These contributing analyses achieved the assessment objectives. This summary document provides a general overview of the results generated from each of the contributing analyses. A very brief and general description of each analysis is provided. For further details please refer to the respective reports.

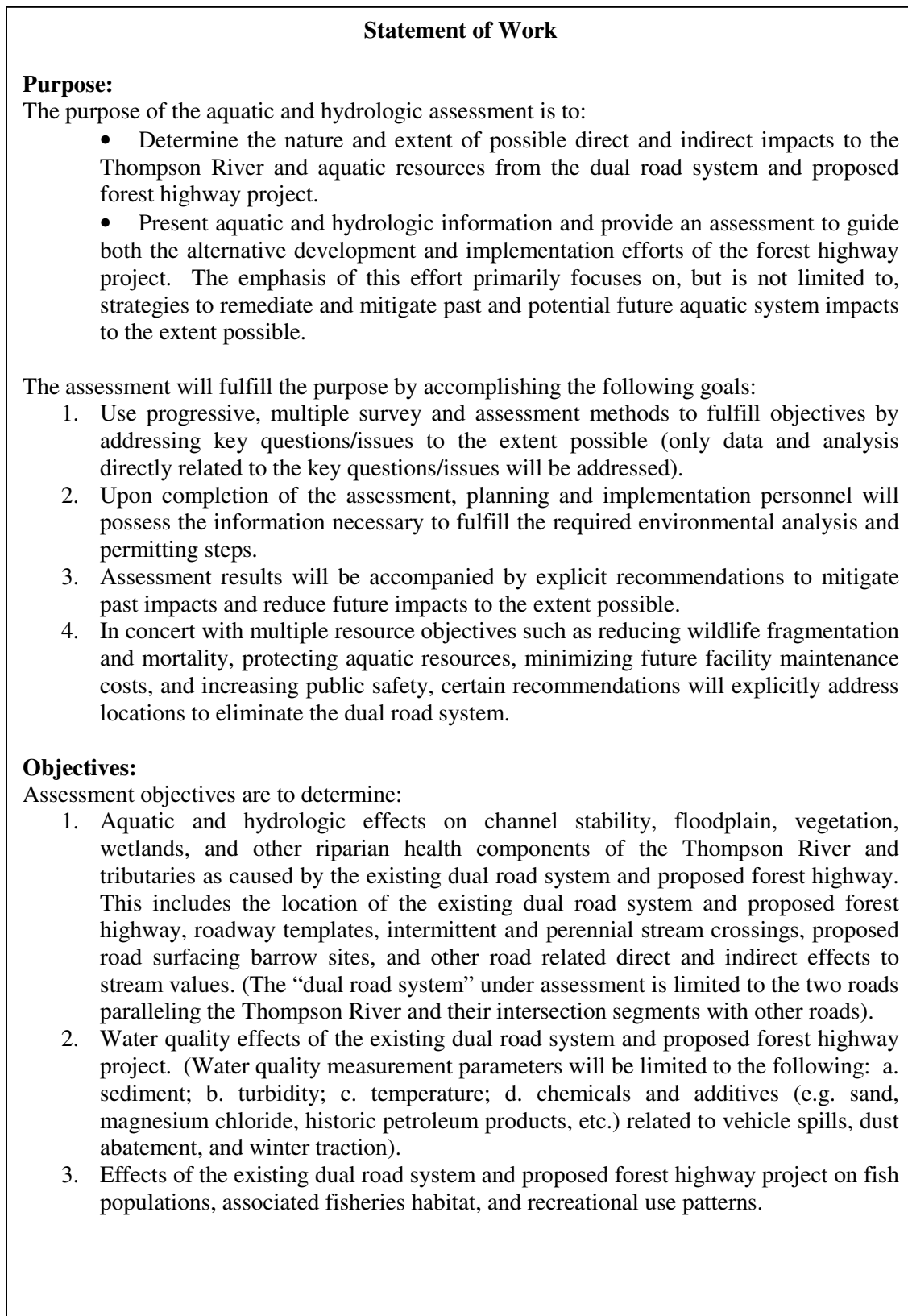
Individual assessment reports summarized in this document include:

- | | |
|--------------------------------------|---|
| 1. Stream channel morphology, | Sylte et al., 2005. Lolo National Forest |
| 2. Fluvial geomorphic trends, | River Design Group, Inc., 2005 |
| 3. Stream bank condition, | Kutzman et al., 2005. Lolo National Forest |
| 4. Riparian vegetation, | Geum environmental Consulting, Inc., 2005 |
| 5. Large woody recruitment, | Geum environmental Consulting, Inc., 2005 |
| 6. Wetland delineation, | Geum environmental Consulting, Inc., 2005 |
| 7. Road sediment delivery, | Kutzman et al., 2005. Lolo National Forest |
| 8. Riparian shade, | River Design Group, Inc., 2005 |
| 9. Road contaminants, | River Design Group, Inc., 2005 |
| 10. Stream substrate - McNeil cores, | River Design Group, Inc., 2005 |
| 11. Stream crossings, | Copenhaver, et al., 2005. Lolo National Forest |
| 12. Aquatic habitat, | Copenhaver, et al., 2005. Lolo National Forest |
| 13. Fish populations, | Copenhaver, et al., 2005. Lolo National Forest |
| 14. Fish angling/recreation, | Katzman, 2006. Montana Fish, Wildlife and Parks |

This document also comprises the final two assessment topics not reported separately:

- 15. Summary assessment of proposed alignments and road decommissioning**
- 16. Assessment of stream rehabilitation needs**

Figure 1. Statement of work including assessment purpose and objectives



Overview of the Thompson River Corridor

(from Geomorphic Trends Report)

10 Reaches

Floodplain and river ecosystems are dynamic mosaics that adjust over time to local and watershed-level changes in discharge, sediment delivery, debris inputs, and riparian vegetation conditions. Valley morphology influences channel and floodplain conditions according to valley bottom width, slope, and valley wall interaction with the channel. Narrow valley bottoms constrict the floodplain-river environment, while broader valley bottoms permit floodplain building and lateral channel migration. Valley bottom or floodplain slope in part affects channel and floodplain morphology by influencing stream energy. Higher gradient floodplains are typically associated with greater stream energy and straighter channel planforms. Flatter floodplain gradients generally support more sinuous, lower energy channel types. Although floodplain gradient has an important influence on channel pattern, other controlling variables include discharge, sediment particle size distribution, and riparian vegetation condition. Valley wall interaction with the river also influences channel pattern via sediment delivery, sediment transport efficiency, and channel scour. Floodplain buffers separating a channel from the adjacent valley wall may also influence sediment transport and storage, flood water conveyance, and channel stability. Valley morphology influence on the floodplain-river environment affects channel morphology.

The Thompson River Corridor was delineated into 10 geomorphic reaches from the mouth of the Thompson River upstream to Lower Thompson Lake (Figure 2, Table 1). Six reaches initially delineated by the Lolo National Forest (LNF) were further broken into 10 reaches based on known and probable stream types (Rosgen, 1994) and valley morphology. Valley slope and valley bottom confinement were examined using topographic slope derived from a 30-m digital elevation model (DEM). Stream types were determined based on field data collected by the LNF, aerial photograph and map review, and knowledge of the area.

Valley morphology in Reaches 1 through 8 of the Thompson River corridor consists primarily of Rosgen Valley Types IV (gentle gradient canyons, gorges and confined alluvial valleys) and VI (moderately steep, fault or structural/bed rock controlled valleys) (Rosgen, 1994). Typical stream types in confined alluvial valleys of the Thompson River corridor include F and C types (Rosgen, 1994). In structurally controlled valleys of the Thompson River, B and C types predominate. In Reaches 9 and 10, the predominant Rosgen Valley Type is Type V (U-shaped glacial trough) (Rosgen, 1994). Most common stream types found in Valley Type V are D and C. E stream types may also be found in Valley Types IV, V and VI (Rosgen, 1994).

The stability of the stream types found in the Thompson River corridor varies. C and E stream types similar to those found in Reaches 1, 2 and 4-10, while inherently stable, are sensitive to disturbance including changes in bank stability, watershed condition, and flow regime. C channels tend to laterally migrate across the floodplain expanse and create new floodplain surfaces while eroding old ones. In a natural state, the migrating channel will maintain the average hydraulic geometry as the channel transports its sediment load and conveys its discharge. Under altered conditions typified by channelization, riparian vegetation removal, or changes in sediment delivery to the channel network, the C and E channels may depart from dynamic equilibrium. Channel incision (transition to F stream type) or braiding (transition to D stream type) may occur in response to disturbances.

B stream types, similar to those found intermittently in all reaches of Thompson River corridor, and throughout Reach 3, are also inherently stable and relatively resistant to disturbance. The B stream types found in the Thompson River corridor are typically structurally controlled by lateral hillslopes and bedrock; floodplain development is moderate with relatively narrow, sloping and well-vegetated floodprone areas.

D and F stream types are less stable and are sensitive to disturbance. Bank erosion rates and sediment supply are high in both D and F stream types. Accelerated sediment delivery and channel aggradation (D stream type) and incision (F stream type) processes impair water quality and aquatic habitat.

The Geomorphic Trends Report provides a general characterization of the stream reaches. The characterization incorporates multiple variables including approximate stream length, valley bottom and floodplain attributes, reach confinement, stream type, road and tributary locations, predominant vegetation type and land management. These characterizations are summarized in Table 1. Where positions relative to the stream are provided (e.g. left bank or right bank, east or west), the notation assumes the downstream-facing direction.

Table 1. General characteristics of reaches in the Thompson River corridor.

Reach Number	Reach Description	Length (miles)	Valley Width	Floodplain Width	Channel Types	Route 56 Relative to River	Route 9991 Relative to River	Vegetation*	Management+
10	Confined E	9.2	wide	wide	E	Crosses at Murr Creek.; L	R; crosses above Lang Creek	AG, RCG, W	Private, some PCTC and MT
9	Confined C/E	3.1	intermediate	intermediate	C, E, B	R adjacent below Shroder; R above Shroder	R adjacent below Shroder; R above Shroder	S, H, RCG	PCTC, some MT
8	Unconfined C	5.2	wide	wide	C,E	L adjacent lower; crosses at Bend; R adjacent and R upper	R adjacent	S, AG	PCTC, private, LNF
7	Confined C/B	6.1	narrow	narrow	B, C, E	L	L lower; crosses below Big Rock Creek; R upper	S, T	PCTC, MT
6	Confined C	4.6	narrow	narrow	C, B	L	L	S, T	PCTC, some MT
5	Unconfined C/E	4.3	wide	wide	C, E,D	R lower; crosses above Bear Creek; L upper	R lower; R adjacent upper; crosses at Chippy Creek	S, H, T	PCTC, MT
4	Confined C transition	5.1	intermediate	intermediate	C, B	R	L adjacent below Little Thompson River; R adjacent above	S, H, T	PCTC, some MT and LNF
3	Confined B	4.9	intermediate	intermediate	B, F	R adjacent	L adjacent	S, H, T	LNF upper; PCTC with some MT and LNF lower
2	ConfinedC	6.2	narrow	narrow	C,F	R adjacent	L adjacent	S, H/RCG, T	LNF
1	Confined B	4.4	narrow	narrow	B, F, C	R adjacent	L adjacent accept lower 1 mile	S, H	PCTC, private, LNF

* S= shrubs; H = herbaceous; T = trees; RCG = reed canarygrass; AG = agricultural grasses; W = wetland species

+ PCTC = Plum Creek Timber Company; LNF = Lolo National Forest; MT = State of Montana

Geology

While a separate geology assessment was not conducted, a brief geologic overview is provided here because it contributes to the fluvial geomorphic characteristics described below.

The underlying geology of the upper half of the Thompson River valley is lower metasedimentary Belt rocks which have broadened into a wide valley as a result of glaciation while the lower half has more bedrock outcrop influence from upper Belt rocks. The lower valley is narrower than the upper valley. On top of this underlying geology, quaternary alluvium overlies the upper three quarters (from the middle of Reach 3 up through Reach 10). The Big Draw Fault intersects the valley from southeast to northwest across Reach 9. Across the middle of Reach 3 the alluvium deposits contact with the Wallace Formation Belt rocks that persist through much of Reach 2. The Wallace Formation Belt rocks then contact the Ravalli Group Belt rocks in lower Reach 2 and throughout Reach 1 (Figure 3).

The influence of geology on water temperature may be partially driving fish population distributions. Warmer temperatures upstream of mile 18 may be a result of the shallow aquifer within the alluvial deposits filling the valley floor. Deeper, cooler water in the alluvial aquifer is forced to the surface as the bedrock shallows toward the contact between the alluvial deposits and the Wallace formation.

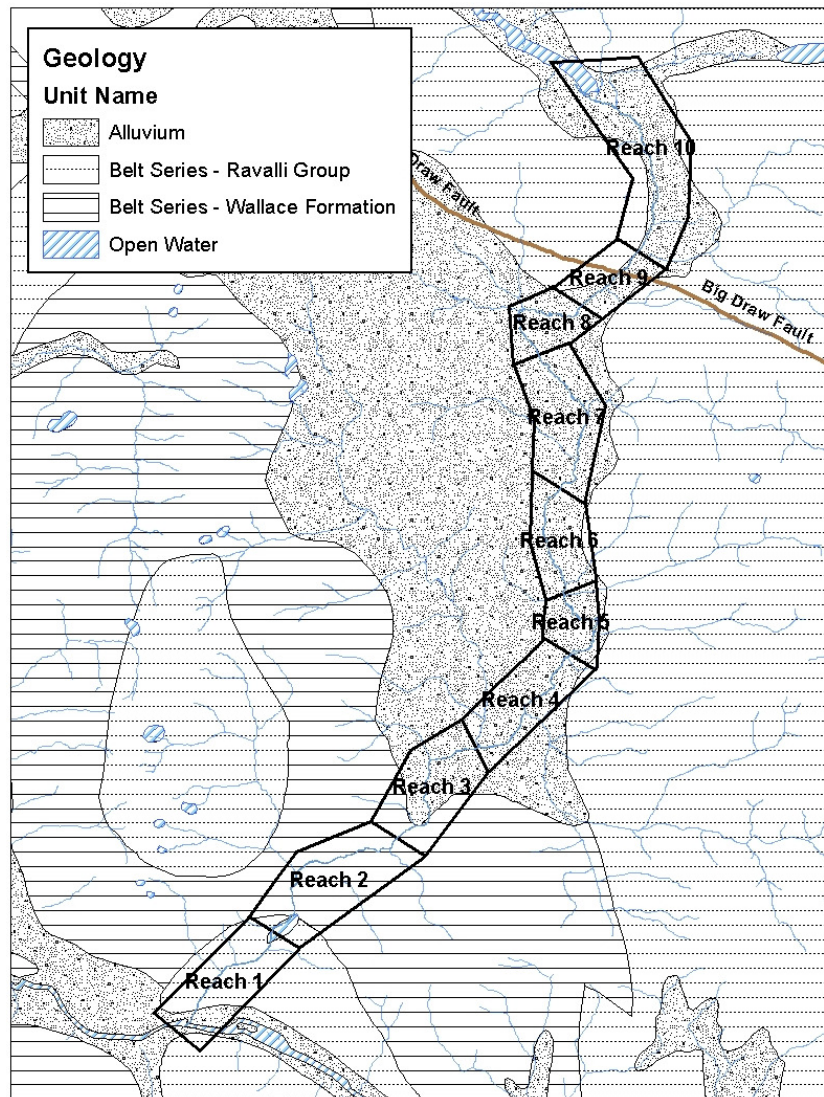


Figure 3. Geology of the Thompson River area (1:500,000)

Summary of Individual Assessment Reports

Each of the individual assessment reports are summarized in the sections below. Table 2 summarizes the results from most of these analyses.

1. Stream Channel Morphology

Morphologically, Routes 56 and 9991 appear to mostly impact the lower portion of the Thompson River by decreasing floodplain capacity, increasing channel entrenchment, and causing certain stream reaches to be wider and shallower than they would be in the absence of roads. These effects likely have influences on flood water and sediment conveyance, stream energy, bank erosion, aquatic and riparian habitat health and complexity, existing and potential large wood availability, increased winter icing in localized reaches, increased temperature, and possibly additional effects.

Bedrock control occurs frequently along the Thompson River (primarily the lower section) and has likely provided grade control and vertical stability to the stream despite various other impacts. Aggradation is limited and localized. It occurs primarily below tributary confluences where sediment inputs from tributaries is deposited and at confining points along the stream and valley.

Most C stream types are in various stages of altered conditions; reference C stream reaches occur mostly in the upper watershed. Altered C and F stream types generally occur lower in the watershed where Routes 56 and 9991 encroach on the stream and reduce flood capacity. Altered C reaches appear to be wider and shallower than reference and typical C reaches. This is symptomatic of other problems such as reduced habitat complexity, reduced flood capacity, increased lateral shear stress and bank erosion, increased summer temperature, decreased winter temperature, and ice. Additional hydraulic analysis, explained below, confirms this. Altered C reaches also have a lower entrenchment ratio compared to reference and typical C reaches and therefore have lower floodplain capacities where roads encroach. This results in reduced riparian area and LWD recruitment. Remnant C channels cut off from the Thompson River by roads exhibit higher bed elevations and greater floodplain area.

Width-to-Depth

Within stream type classes, there is a wide range of width-to-depth ratio values (W/D). This is especially true for C stream types. W/D ratios for this class of stream generally lie within the higher range of values. This could be a result of fluctuations in sediment and/or water supply. Other possible influences may include channel manipulation, beaver, or other causes. Known sediment inputs include landslides in Fishtrap and West Fork Thompson tributaries, the toes of which are periodically activated by flood flows, rejuvenating sediment pulses to the Thompson River. Some of the landslides originated where roads interact with unconsolidated Glacial Lake Missoula deposits.

Of the 33 cross sections surveyed in C channels not recorded as “impaired” or “remnant”, W/D ratios ranged from 17.5’ to 66.4’ and averaged 35.0’. For the 17 cross sections completed in C

channels listed as “impaired”, W/D ratios ranged from 17.7’ to 58.0’ and averaged 34.8’. For the 2 cross sections completed on C channels listed as “remnant”. W/D ratios were 19.1’ and 21.3’.

Channel manipulation has occurred throughout the watershed and includes straightening in the upper watershed on private land to make room for pasture and agriculture. In these areas, incision and bank erosion have resulted as the stream adjusts to channel straightening, producing additional sediment. Channel straightening has also occurred in the lower watershed to accommodate Routes 56 and 9991.

Bank Height

Bank heights were evaluated in E stream types to determine if channel incision has occurred as E stream types are sensitive to incision. Impaired E channels are generally located near agriculture and pasture land uses, have much higher W/D ratios than reference E types (280% and 533% higher), and support low riparian vegetation diversity (mostly reed canary grass and hawthorn and single-age shrubs). E reaches appear to have vertical stability; there has been little incision as demonstrated by fairly constant bank heights. Channel incision was observed locally in other reaches. No long reaches of channel incision were identified; channel incision is not systematic throughout.

Entrenchment Ratio

Study of entrenchment ratio suggests that reference and other typical C reaches have more floodplain than altered C reaches. F and Fb stream types were also similar to altered and typical C stream reaches in that there was less available floodplain than the reference C reaches. Less floodplain equates to less riparian area and a different hydrology than the natural or reference condition. Having less floodplain also likely results in a change to channel dimension, pattern, and profile by creating more bed and bank scour. It also means less riparian area and less large wood recruitment.

Large Woody Debris

Large woody debris (LWD) is uncommon throughout the Thompson River. It has little impact on the morphology of stream channel, although the lack of LWD likely does impact morphology in that there are few pools and/or pool depths are shallow as found in the habitat assessment.

Meander Cutoffs

Decreased floodplain and sinuosity (channel straightening) as a result of meander cut offs has resulted in greater stream power, as evidenced by the 1-3 feet of down cutting observed (See Figures 5, 6 and 8 in the Channel Morphology Analysis report). Remnant channels and existing channels have similar dimensions, although remnants have more floodplain area and existing channels are 1-3 feet below the elevation of the remnant channels. Initial impacts, such as increased sediment from channel scour and subsequent aggradation, have likely dissipated as aggradation is now limited. As described in the following section, overall point bar area has decreased over time.

Table 2. Summary of Existing Conditions. (Geomorphic trends, aquatic habitat, fish population and fish angling information presented separately below).

Reach	Geology	Valley/Channel Morphology	Bank Conditions (Percent of Bank with Moderate, High, or Very High BEHI Rating)	Area of roads that are within mapped riparian area (acres)	Area of mapped potential riparian area (acres)	Large Woody Debris		Wetlands		Road Sediment (tons)			Riparian Shade (percent)	Number of Crossings River (Major Tributary)	Stream Crossing Assessment		Road Contamination	Fish Population Density (Fish/100 m ²)		McNeil Cores *Interpretations based on number of roads and proximity, and on reach characterization (B vs C = transport versus depositional).
						Area of tree communities in LWD recruitment zone (acres)	Area of LWD recruitment zone occupied by roads (acres)	Mapped (acres)	Hydric Soils (acres)	Total	56	9991			Tons of Fill at Risk (Q2; Hw:D = 1.0)	Number of Barriers (Miles of upstream habitat)		Non-Native Trout	Native Trout	
10	Alluvium	Unconfined, Very wide, E	NA	3.6	979.9	123.6	9.6	25.6	157.6	0.1	0.1	0	20.7	1 (0)	NA	NA	NA	NA	NA	*Likely low to moderate
9	Alluvium	Confined, Wide, C,E,B	12	2.5	73.2	48.4	11.5	2.9	10.1	1.3	0.4	0.9	31.1	1 (0)	NA	NA	NA	NA	NA	*Likely moderate to high
8	Alluvium	Unconfined, Wide, C&E	16	1.9	155.6	85.4	3.7	12.9	16.5	0.6	0	0.6	18.3	1 (2)	505	2 (1.7)	NA	6.5	0.0	*Likely moderate to high
7	Alluvium	Confined, Narrow valley&FP, B,C w/E	8	1.8	169.8	175.3	5.8	1.1	18.3	0.8	0.5	0.3	42.8	1 (1)	17	NA	NA	5.8	0.0	Low (1.7% <6.35mm 5.4% <2.36mm)
6	Alluvium	Confined, Narrow valley&FP, C w/B	6	0.2	122.0	136.6	0.9	12.3	16.3	0.1	0.1	0	48.6	0 (2)	72	2 (2.7)	NA	16.9	0.0	*Likely low to moderate
5	Alluvium	Unconfined, Wide valley& FPC w/D&E	11	1.3	159.1	105.0	5.3	1.4	25.8	0.4	0.2	0.2	37.7	2 (2)	0	1 (17.1)	NA	3.8	0.2	*Likely low to moderate
4	Alluvium	Confined, transition,Wider valley & FP, C/B	31	12.3	96.6	145.7	18.9	11.0	24.7	0.5	0.3	0.2	9.6	1 (2)	NA	NA	NA	6.4	0.0	Moderate (20.6% & 15.7% <6.35mm 9.0% & 7.9% <2.36mm)
3	Belt-Wallace/Alluvium	Confined, Wider valley&FP, B w/ F	27	7.5	36.1	114.3	40.6	0.2	No data	2.9	1.8	1.1	26.2	0 (2)	575	1 (2.8)	NA	8.4	0.1	High (27.1% <6.35mm 15.1% <2.36 mm)
2	Belt-Wallace/Belt-Ravalli	Confined, Narrow valley & FP, C/F	39	27.9	85.3	145.1	51.0	8.1	No data	1.9	0.8	1.1	7.1	0 (3)	252	1 (4.4)	Present; exceeds State standards	19.3	0.3	High (23.1% <6.35mm 12.7% <2.36 mm)
1	Belt-Ravalli/Alluvium	Confined, narrow valley & FP; B/F w/ C	26	3.1	49.9	95.9	30.9	0.6	0.5	20.1	13.5	6.6	10.1	1 (3)	933	1 (4.8)	Present; exceeds State standards	3.5	0.1	*Likely high
Total			20	61.8	1927.6	1175.3	178.9	76.1	269.8				21.4	8 (17)	2354	8 (33.5) 4	NA			

2. Fluvial Geomorphic Trends

The results of all Geomorphic Trends analyses are summarized in Table 8.

Sinuosity and Pools

The Thompson River channel length decreased in Reaches 1 through 4 and increased in Reach 6 from the 1940's to 2000. Channel length reductions for Reaches 1 through 3 ranged from 0.6 % to 3.0% while the channel length in Reach 4 decreased 6.2%; conversely, the channel length in portions of Reach 6 increased by 2.9%.

Channel sinuosity changes were correlated to the observed changes in channel length. Overall, sinuosity decreased in Reaches 1 through 4 (Figure 4) with the calculated reduction closely related to road encroachment and meander truncations.

Figure 4 displays a positive correlation between sinuosity and percent pools: the more sinuous the stream, the greater number of pools. Figure 5 shows that 3 of the 5 reaches analyzed in the 1940's and again in 2000 (Reaches 1, 3, and 4), decreased in sinuosity (reduced channel length). Of the other 2 reaches analyzed, one increased in sinuosity (Reach 6) and the other remained relatively unchanged (Reach 2). By combining the relationships displayed in Figures 4 and 5, it can be inferred that less sinuous channel conditions in reaches 1, 3, and 4 today (2000) are associated with reduced pool habitat. Increased sinuosity in Reach 6 appears to be a result of lateral channel migration and point bar development, overall channel lengthening, and is associated with relatively high percent pools. (See also Figures 14-18).

As subsequently described, road encroachment in Reach 6 is lowest out of all reaches analyzed. Other indicators suggest that stream and floodplain function is greatest in Reach 6. Relatively low road encroachment in reaches 5, 7, 8, and 9 is also associated with higher sinuosity and greater percent pools. Road encroachment is greatest in reaches 1 through 4, where sinuosity and percent pools is lowest.

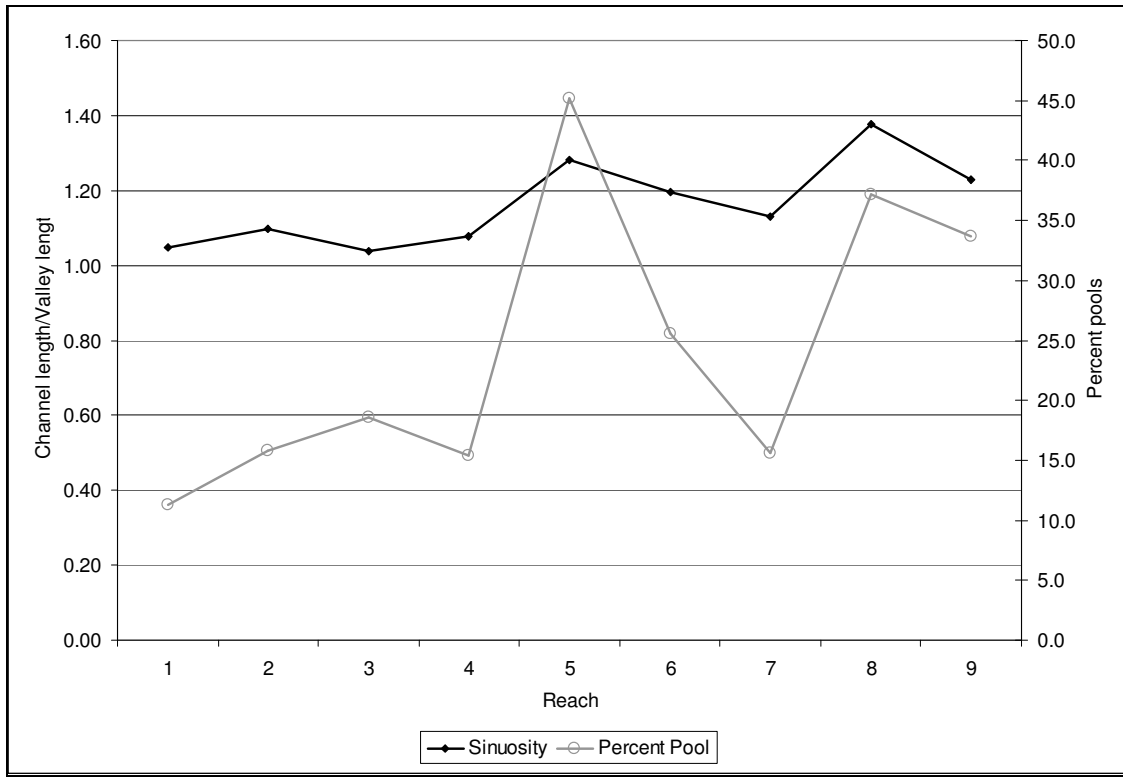


Figure 4. Existing (2000) relationship between sinuosity (channel length/valley length) and percent pools.

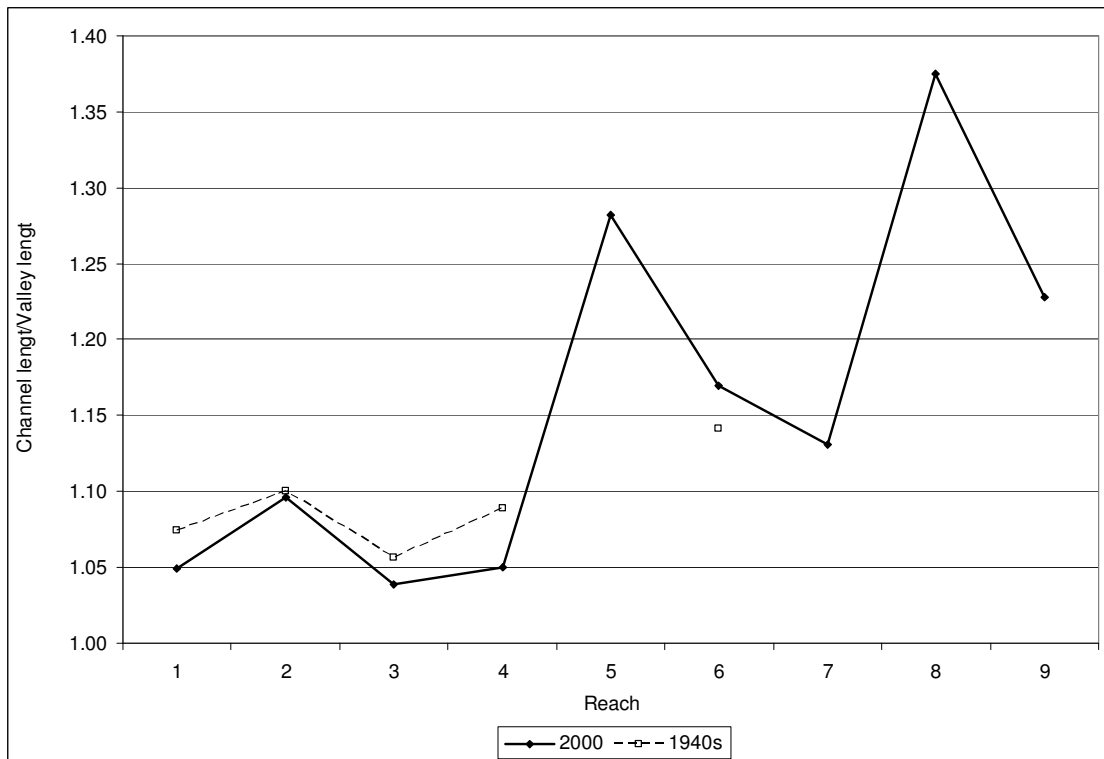


Figure 5. Change in sinuosity between 1940s and 2000.

Stream Power and Particle Size

Hydraulic analysis of stream power and moveable particle size compared remnant historical cross sections with existing channel cross sections. Analysis results (Table 3) show the historic threshold grain sizes in Reach 4 (33.3 to 52.2 mm) are smaller than both the D50 and D84 of the existing channel (63 and 134 mm respectively). The historical channel cross-section's width-to-depth ratio is greater than that of the existing channel cross-section (21.2 versus 17.7). This suggests that historical channel conditions resulted in less stream power than existing conditions, implying that existing conditions have a greater ability to scour the channel bed and banks.

For Reach 2, stream power is currently lower than the probable historical conditions, however, the hydraulic calculations are based on a partial cross-section. The existing threshold grain size (34.2 mm) is smaller than the historic (67.9 mm), indicating greater stream power under historical conditions. However, because hydraulic calculations in Reach 2 are based on a partial remnant cross-section, results for Reach 2 may not be accurate.

Calculated values of existing threshold grain size are approximately equal to the existing, measured D50 (57.1 mm calculated; 63 mm measured) which helps to validate this analysis. Back-calculated threshold grain size for the historical channel is smaller (46.3 mm), further suggesting that stream power under historical conditions was lower than existing conditions.

Table 3. Hydraulic parameters and results for existing and remnant channel cross-sections in areas of channel truncation.

	Reach 4				Reach 2	
Parameter	Existing 10A	Remnant 10A	Existing 15.5	Remnant 15.5	Existing 3A	Remnant 3A**
Hydraulic Radius (R) (ft)	3.6	3.3	--	2.6	2.1	3.7
Manning's n-value	0.040	0.040	--	0.040	0.042	0.042
XSA (ft ²)	253	246	--	138	198	139
Slope (S) - Measured from Existing Condition	0.39	0.39	--	0.39	0.42	0.42
Discharge (cfs)	1,387	1,270	--	607	744	--
Unit Stream Power (lb/ft/sec)	5.038	4.290	--	2.878	2.133	5.922
Shear Stress (lb/sq ft)	0.88	0.81	--	0.64	0.55	0.97
Threshold Grain Size (mm)	57.1	52.2	--	40.1	34.2	67.9
Channel Length (ft) (photo interpreted)	1,275	1,425	825	975	--	--
Slope (S) - Back Calculated for Historical Condition	--	0.35	--	0.33	--	--
Discharge (cfs)	--	1,203	--	558	--	--
Unit Stream Power (lb/ft/sec)	--	3.647	--	2.240	--	--
Shear Stress (lb/sq ft)	--	0.72	--	0.54	--	--
Threshold Grain Size (mm)	--	46.3	--	33.3	--	--
Other Related Morphology and Hydraulic Parameters						
Bankfull Width (ft)	67.0	72.1	--	51.3	91.5	33.6
Maximum Depth (ft)	4.7	5.2	--	4.3	3.1	6.9
Mean Depth (ft)	3.8	3.4	--	2.7	2.2	4.1
Wetted Perimeter (ft)	69.6	74.3	--	52.7	94.1	37.6
W/D Ratio	17.7	21.1	--	19.1	42.3	8.1
Width of Floodprone Area (ft)	151	330	--	--	312	312
<i>Entrenchment Ratio</i>	2.3	4.6	--	--	3.4	9.3
Measured D50	63	--	--	--	59	--
Measured D84	134	--	--	--	118	--

**Based on partial remnant cross section.

Road Encroachment Influences

The length of road encroaching upon the Thompson River, to the degree that the road prism is essentially serving as stream bank, is greatest in Reaches 1 through 4. Reaches 5, 7, 8, and 9 are also encroached upon by roads, but to a lesser degree (Figure 6). Roads do not encroach upon the Thompson River in Reach 6 to the degree that the road prism serves as stream bank.

Planform

Meander belt width has decreased in all reaches, reflecting increased confinement of the river corridor by roads (Figure 6). Percent decreases in average belt width per reach range from 1% (-4 feet) in Reach 6 to over 44% (-135 feet) in Reach 2. Mean belt width has been reduced by 30% or more in 5 reaches (Reaches 1, 2, 4, 8, 9). The greatest decreases in belt width are generally associated with the greatest length of road encroachment (road prism as stream bank).

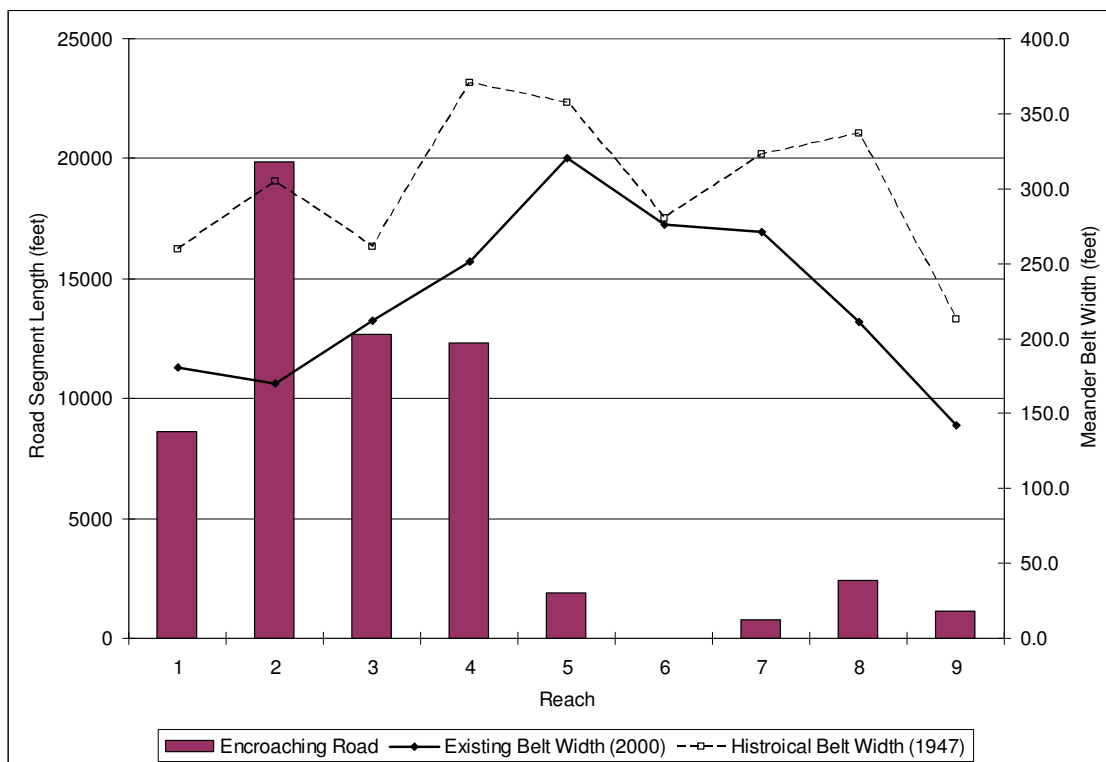


Figure 6. Length of encroaching road (road as stream bank) and associated mean meander belt width changes by stream reach.

Channel Width

Changes in channel widths have varied over time, as observed by reach and by photo plate (Figure 7). Overall, the analysis showed decreases in mean channel width from the historical photo series to the more recent photos (Reaches 1, 2, 4, 6 and 7). Decreases in mean channel width may be the result of increased stream power and channel incision. Mean channel width in Reach 3 increased slightly, although both increases and decreases in channel width were observed within the reach.

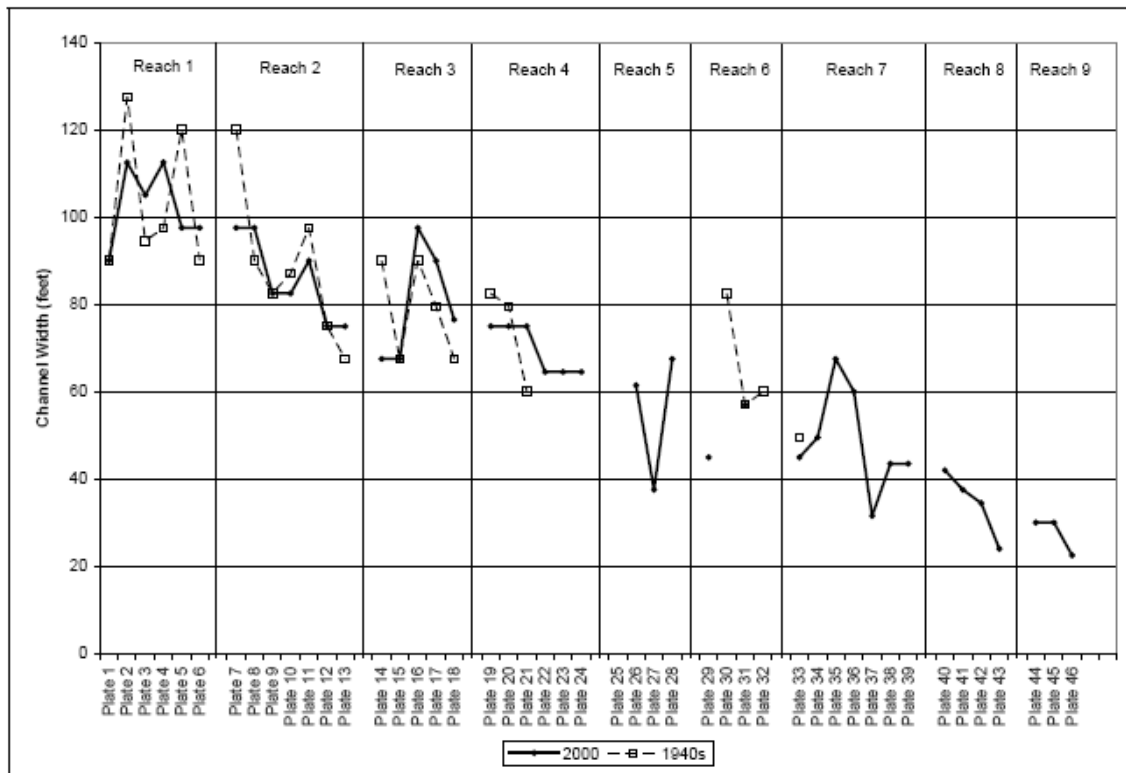


Figure 7. Average channel widths (excluding minimum and maximum values) are presented on the Y-axis for each photo plate on the X-axis. Values are grouped by Reach across the top.

Stream Bars

Several generalizations can be made regarding sediment movement through the Thompson River system based on the results of the multi-temporal and spatial bar analysis. Trends in bar area correlate to past discharges and to conveyance of sediment through the Thompson River.

There was an increase in bar deposits between the 1940's and 1960's aerial photos in Reaches 3 and 4 (Figure 8). Sediment from upstream sources may have been deposited in Reaches 3 and 4 by the 1948 and/or 1964 flood events (Figures 8 and 9). The peak discharges in 1948 and 1964 exceeded 6,000 cfs (Figure 9), approximating 25 year flood events (Figure 11). In that same time period, bar deposits in Reach 2 appear to have been transported out of the reach, and deposited in Reach 1 or mobilized through the system to the Clark Fork River (Figure 8).

After the 1964 flood event, annual peak discharge generally declined into the late 1980s and early 1990s (Figure 9). The decline in discharge is accompanied by decreased bar area between 1967 and 1982 in Reaches 1 through 4 (Figure 8). There appears to have been a reduced amount of sediment stored in-channel in the form of depositional bars.

Between 1982 and 1995, there is a gradual increase in annual peak flows (Figure 9). Bar development also increased in Reaches 1, 3, 4, 6, 7, and 9 during this time (Figure 8). Reaches 2 and 8 experienced a decrease in bar area from 1982 to 1995. The two largest flows during this time were 2,760 cfs in 1982 and 3,110 cfs in 1991 (Figure 9), both approximating 3 year flood events (30% exceedence probability).

Bar area in Reaches 5, 6, and 9, which had increased from 1982 to 1995, decreased between 1995 and 2000 (Figure 8). The sediment was likely mobilized by peak flows greater than 5,000 cfs in 1996 and 1997 (Figure 9). The sediment likely deposited in Reaches 1 through 4, 7, and 8, all of which exhibited increased bar area for the same time period.

Based on the 2000 photos, bars were concentrated in Reaches 4, 2, and 7 (Figure 8). A peak flow of 4,570 cfs in 2002 (Figure 9) likely mobilized the sediment observed in the 2000 aerial photo bars as well as recruited new sediment from the channel, banks, and tributaries. The 2002 flow was an 8.5 year flood event with a 12% exceedence probability (Figures 10 and 11).

From qualitative observations, areas of road encroachment upon the stream were frequently accompanied by areas of downstream deposition. This observation suggests that road encroachment has caused localized channel scour at the channel-road fill-slope interface, and downstream deposition of the scoured substrate.

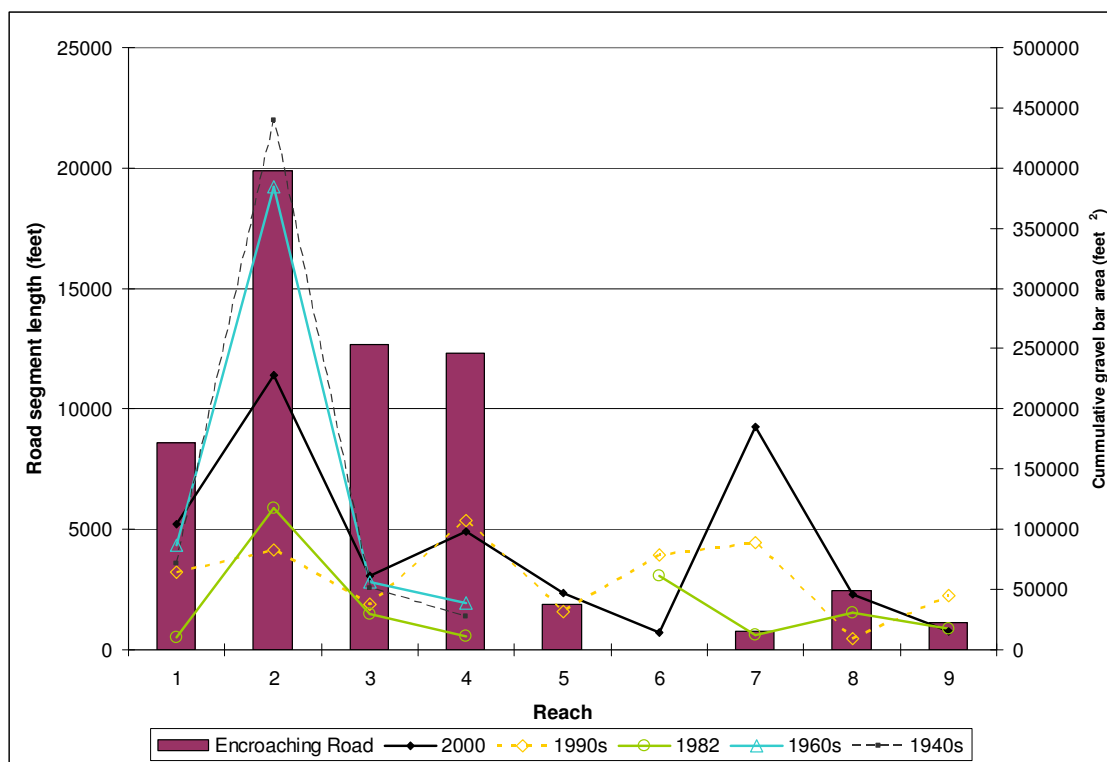


Figure 8. Length of encroaching road (road as stream bank) and associated deposition bar area.

As described above, bar distributions have varied over time. Total bar area has decreased in some reaches and increased in others. Sediment supplies have likely varied over time. More sediment is made available in wetter periods and less sediment in drier years. Sediment supply has also likely varied as a result of land management as well as natural events. Bed and bank scour from channel alterations and bank hardening has also likely created an increase in sediment supply. Bar area increases in some reaches between the 1990's and 2000 may be explained by the 1996 and 1997 flood events. Decreases in other reaches may represent improved transport efficiency or simply transport from reach to reach.

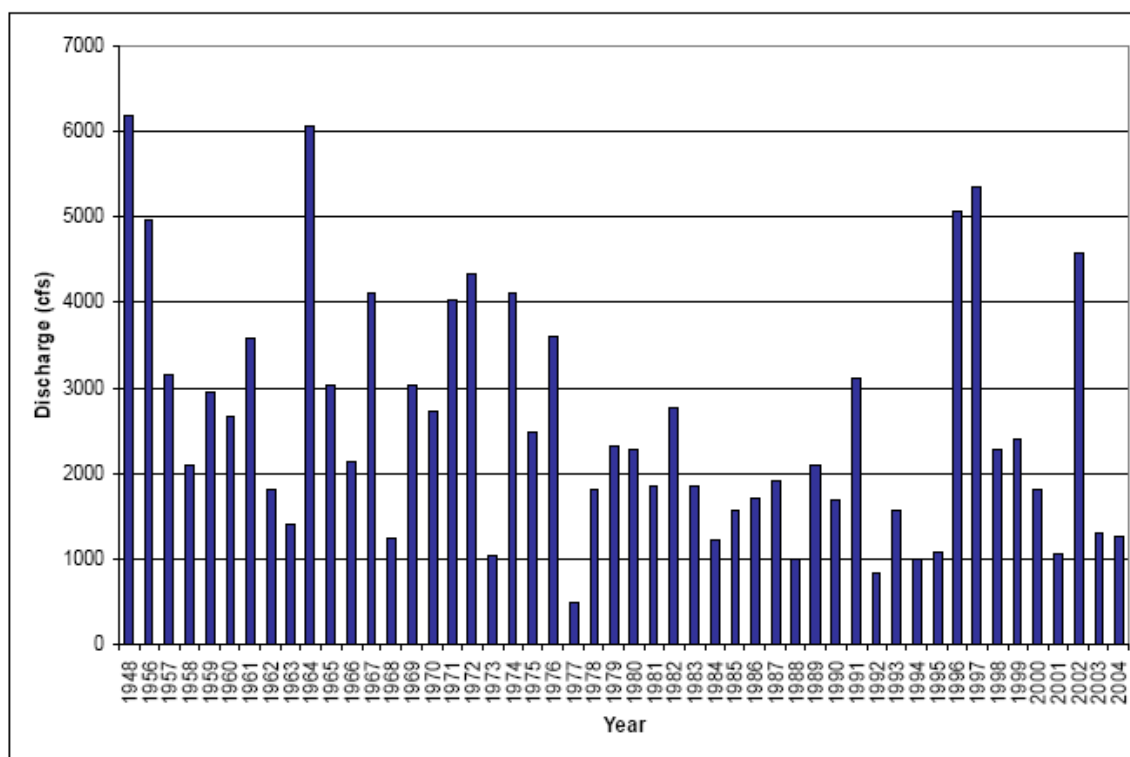


Figure 9. Annual peak discharges (Y-axis) for the Thompson River over a 56-year record (X-axis).

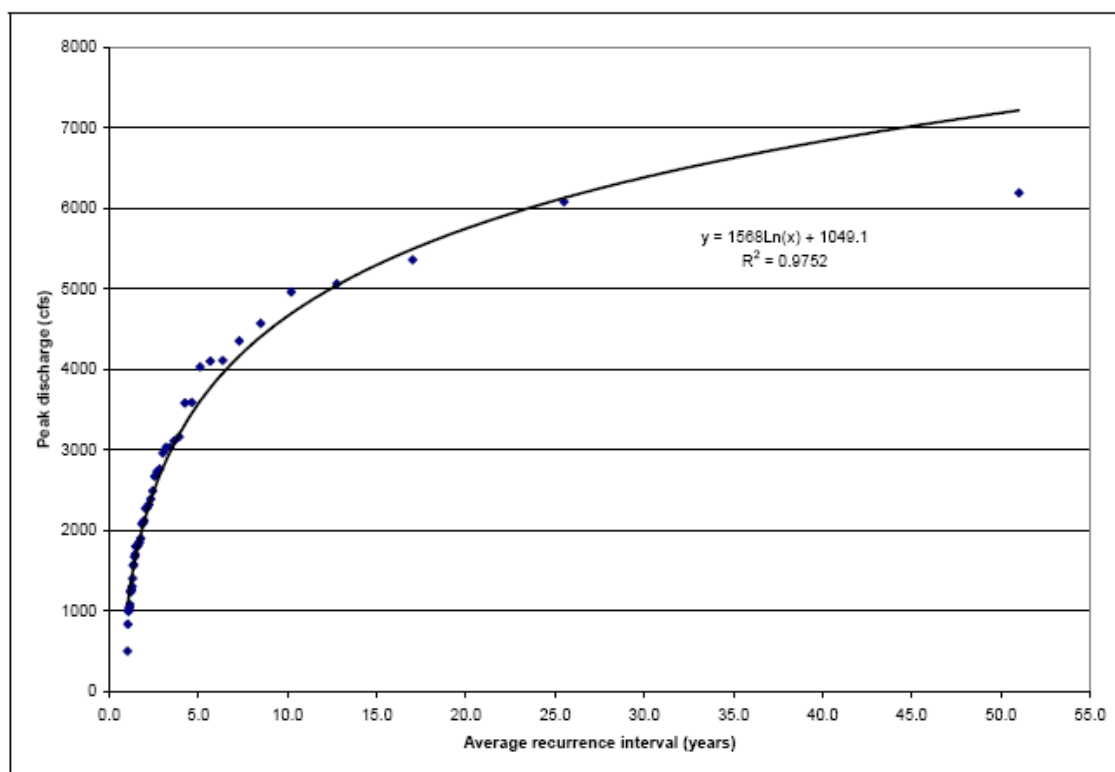


Figure 10. Peak discharge (Y-axis) recurrence interval (X-axis) for the Thompson River.

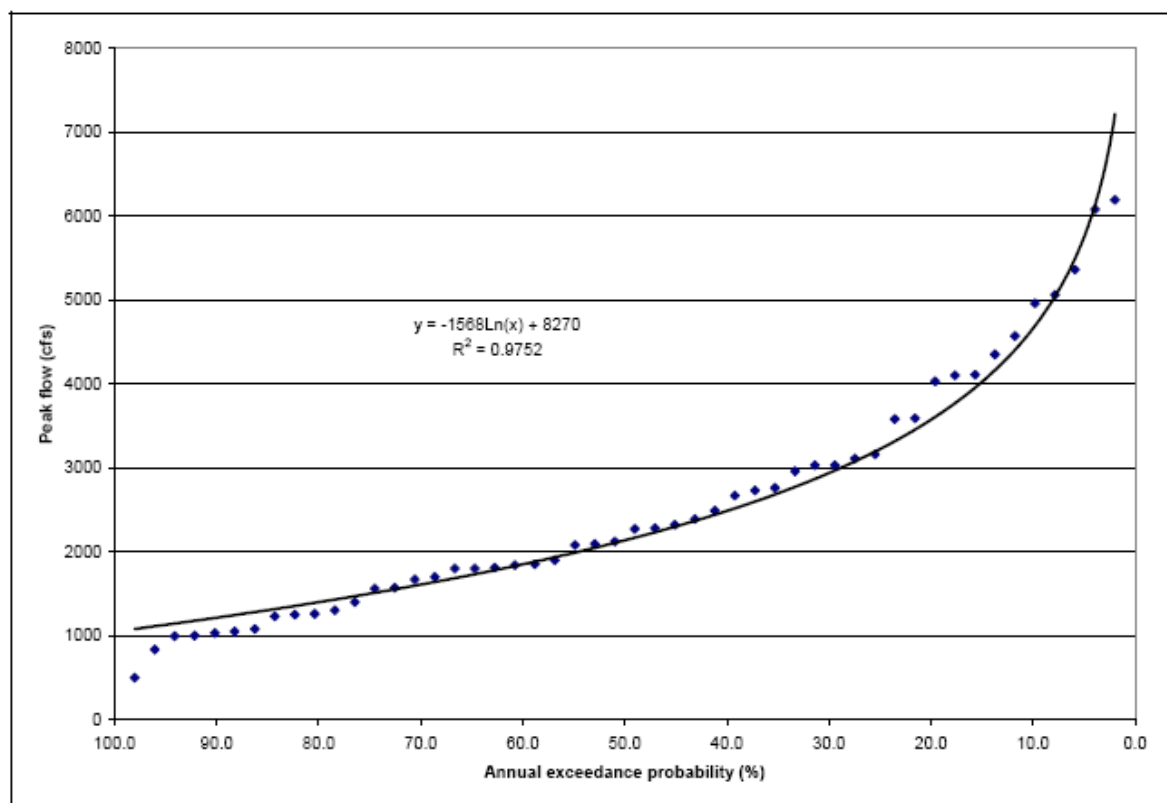


Figure 11. Flood frequency curve for peak discharges (Y-axis) and annual exceedance probabilities (X-axis) of the Thompson River.

Meander Cut-offs and Truncations, Floodprone Width and Road-Stream Buffers

The number of meander cut-offs varied by reach with the greatest number of cut-offs in Reach 2 (32 cut-offs) and Reach 3 (18 cut-offs) (Table 8). Reach 4 (16 cut-offs), Reach 8 (9 cut-offs), and Reach 9 (3 cut-offs) also exhibited road encroachment that resulted in meander cut-offs. Meander truncations were most frequent in Reach 2 (6 truncations), Reach 4 (4 truncations), and Reach 3 (2 truncations). The length of road encroaching upon the stream was almost directly related to the number of meander truncations (Figure 6). See also Figure 12.

Currently, 86 acres (4.5%) of floodprone area are occupied by road prism, 60.1 acres (3.2%) by Route 9991, and 25.9 acres (1.4%) by Route 56 (Tables 4 and 5). The FHWA's Preferred Alignment would occupy 30.7 acres (1.6%) of floodprone area while the Secondary Alignment would occupy 63.2 (3.3%) acres.

The greatest percent/area of floodprone area occupied or isolated by existing roads are located in Reaches 2 (23.0%, 36 acres) and 4 (16.1%, 22.7 acres). The Preferred Alignment would reduce that area to 7.7% (12.1 acres) in Reach 2 and to 1.0% (1.4 acres) in Reach 4. The Secondary Alignment would decrease the floodprone area impacted to 23.4 acres (14.9%) in Reach 2 and to 22.7 acres (16.1%) in Reach 4.

Approximately 7.0% (6.7 acres) and 6.7% (5.1 acres) of floodprone area in Reach 1 and Reach 3 are impacted by existing roads, respectively. The Preferred Alignment would increase the

percentage to 6.8% (6.4 acres) in Reach 1 and would decrease the percentage to 3.4% (2.6 acres) in Reach 3.

Two-percent or less of floodprone area in Reaches 5 through 10 is impacted by the existing road prisms (Table 5). The Preferred Alignment would result in a 1% or less change in area of floodplain impact from the existing condition in Reaches 5 through 10. There would be less than 2% change with the Secondary Alignment.

Table 4. Acres of floodprone area occupied by or isolated from the river by road prisms.

Total FPA Impacts (ac)								
Reach	Primary Stream Type	Existing			Proposed			
		Rte 9991	Rte 56	Both Roads	Preferred Alignment	Change*	Secondary Alignment	Change*
10	Unconfined E	0.7	7.3	8.1	1	-7.1	7.3	-0.8
9	Confined C/E	1.4	0	1.4	1.6	+0.2	0.4	-1.0
8	Unconfined C	2.1	0.3	2.4	2.9	+0.5	0.3	-2.1
7	Confined C/B	0.8	0.1	1.0	1.1	+0.1	0.1	-0.9
6	Confined C	0.1	0.0	0.1	0.3	+0.2	0.0	-0.1
5	Unconfined C/E	1.9	0.7	2.6	1.4	-1.2	0.7	-1.9
4	Confined C Transition	21.5	1.2	22.7	1.4	-21.3	22.7	+0.0
3	Confined B	2.2	2.9	5.1	2.6	-2.5	3.8	-1.3
2	Confined C	25.3	10.7	36	12.1	-23.9	23.4	-12.6
1	Confined B	3.9	2.7	6.7	6.4	-0.3	4.4	-2.3
Total		60.1	25.9	86	30.7	-55.3	63.2	-22.8

*Change from existing condition including both Route 9991 and Route 56.

Table 5. Percent of total floodprone area occupied by or isolated from the river by road prisms.

Total FPA Impacts (%)								
Reach	Primary Stream Type	Existing			Proposed			
		Rte 9991	Rte 56	Both Roads	Preferred Alignment	Change*	Secondary Alignment	Change*
10	Unconfined E	0.1	1.0	1.1	0.1	-1.0	1.0	-0.1
9	Confined C/E	2.0	0.0	2.0	2.2	+0.2	0.5	-1.5
8	Unconfined C	1.2	0.2	1.4	1.7	+0.3	0.2	-1.2
7	Confined C/B	0.5	0.1	0.5	0.6	+0.1	0.1	-0.5
6	Confined C	0.1	0.0	0.1	0.2	+0.1	0.0	-0.1
5	Unconfined C/E	1.2	0.4	1.6	0.9	-0.7	0.4	-1.1
4	Confined C Transition	15.3	0.8	16.1	1.0	-15.1	16.1	0.0
3	Confined B	2.9	3.8	6.7	3.4	-3.3	5.1	-1.6
2	Confined C	16.2	6.8	23.0	7.7	-15.3	14.9	-8.1
1	Confined B	4.1	2.9	7.0	6.8	-0.2	4.7	-2.3
Total		3.2	1.4	4.5	1.6	-2.9	3.3	-1.2

*Change from existing condition including both Route 9991 and Route 56.



Figure 12. Cut-off meanders (top photo; bottom of Reach 4 near mile post 16) and truncated meanders (bottom photo; middle of Reach 8 above Bend) exemplify two adverse impacts of the existing road alignment on the Thompson River.

The length and proportion of stream reach encroached upon by road prism within 125 feet and 300 feet of the stream presented in the Geomorphic Trends report are also shown in Tables 6 and 7. Route 56 and the Preferred Alignment encroach upon the fewest stream miles within 125 feet; 10.2 miles (19.2%) and 12.8 miles (24.1%), respectively. Route 9991 and the Secondary Alignment encroach upon 16.4 miles (30.9%) and 14.4 miles (27.1%) of stream, respectively. Within the 300 foot buffer, Route 56 is the least encroaching (18.3 miles, 34.5%) followed by the Preferred Alignment (21.7 miles, 40.9%), the Secondary Alignment (23.1 miles, 43.5%), and Route 9991 (26.1 miles, 49.2%).

Encroachment by proportion of stream length is, overall, the greatest in Reaches 1 through 3 for all routes. Reaches 1 through 3 have 41% (1.8 miles), 70% (4.4 miles), and 51% (2.5 miles) of stream length within 125 feet of Route 56, respectively. Encroachment from the Preferred Alignment upon Reaches 1 through 3 is similar (41%, 1.8 miles; 64%, 4.0 miles; 66%, 3.3 miles). Large portions of Reaches 1 through 3 are also encroached upon by Route 9991 (53%, 2.4 miles; 73%, 4.5 miles; 68%, 3.3 miles) and the Secondary Alignment (54%, 2.4 miles; 81%, 5.1 miles; 56%, 2.7 miles). A majority (>60%, 3.2 miles) of Reach 4 is also encroached upon (within 125 feet) by the Route 9991/Secondary Alignment. Route 56 and the Preferred Alignment are within 125 feet of 10% (0.5 miles) and 11% (0.5 miles) of Reach 4, respectively. Encroachment of road within 125 feet of the remaining reaches is 22% or less for both existing and proposed routes with the exception of Reach 9. Route 9991 and the Preferred Alignment encroach within 125 feet of 35% (1.1 miles) and 36% (1.1 miles) of Reach 9, respectively.

The Thompson River is within 300 feet of Route 56 and Route 9991 throughout a majority of Reach 1 through 3. Both proposed road alignments would be within the 300 foot buffer from the river. In Reach 4, 18% (0.9 miles) of the river is within 300 feet of Route 56, while the majority (88%, 4.5 miles) of Reach 4 is within 300 feet of Route 9991. All roads are within 300 feet of 16% or less of reaches 5 through 7, and reach 10. One-half of Reach 8 is within 300 feet of Route 9991/Preferred Alignment whereas 12% of Reach 8 is near Route 56/Secondary Alignment.

Table 6. Length of stream (mi) encroached upon by road prism within 125 ft and 300 ft buffer distances.

Buffer distance (ft):		125 ft				300 ft			
Reach	Stream Length (mi)	Rte 56	Rte 9991	Pref.	Sec.	Rte 56	Rte 9991	Pref.	Sec.
10	9.2	0.1	0.2	0.3	0.1	0.7	0.7	0.7	0.7
9	3.1	0.3	1.1	1.1	0.3	1.2	2.1	2.2	1.3
8	5.2	0.1	1.1	1.2	0.1	0.6	2.5	2.5	0.6
7	6.1	0.2	0.1	0.1	0.2	0.9	0.3	0.3	1.0
6	4.6		0.1	0.1		0.1	0.4	0.4	0.1
5	4.3	0.3	0.4	0.4	0.3	0.7	0.6	0.6	0.7
4	5.1	0.5	3.2	0.5	3.2	0.9	4.5	0.9	4.5
3	4.9	2.5	3.3	3.3	2.7	4.0	4.9	4.9	4.0
2	6.2	4.4	4.5	4.0	5.1	6.1	6.1	6.1	6.2
1	4.4	1.8	2.4	1.8	2.4	3.1	4.0	3.1	4.0
Total	53.1	10.2	16.4	12.8	14.4	18.3	26.1	21.7	23.1

Table 7. Proportion (%) of stream length encroached upon by road prism within 125 ft and 300 ft buffer distances.

Buffer distance (ft):		125 ft				300 ft			
Reach	Stream Length (mi)	Rte 56	Rte 9991	Pref.	Sec.	Rte 56	Rte 9991	Pref.	Sec.
10	9.2	1	3	3	1	8	8	8	8
9	3.1	10	35	36	10	39	67	69	40
8	5.2	3	22	22	3	12	47	48	12
7	6.1	3	2	2	3	16	4	4	16
6	4.6	0	2	2	0	1	8	9	2
5	4.3	7	9	10	8	15	13	13	15
4	5.1	10	62	11	64	18	88	18	88
3	4.9	51	68	66	56	81	100	100	81
2	6.2	70	73	64	81	99	99	97	99
1	4.4	41	53	41	54	69	89	70	90
Total		19.2	30.9	24.1	27.1	34.5	49.2	40.9	43.5

Table 8. Summary of geomorphic trend analysis parameters.												
Reach	Change in Stream Length 1940 to 2000 (%)	Change in sinuosity	Percent Pools	Stream Power (lb/ft/sec)	Encroaching Road Length (Length of Road as Streambank) (ft)	Number of Cut-Offs	Number of Truncations	%FP with Road	Mean Belt Width Change %	Bar Area Change (2000-1947 Reach 1-5/ 2000-1982 Reach 6-9) (ac)	Route 56 relative to River	Route 9991 relative to River
10	--	--	--	--	--	0	0	1.1	--	--	Crosses at Murr Creek.; L	R; crosses above Lang Creek
9	--	--	33.68	--	1,125	3	0	2	-33	-0.05	R adjacent below Shroder; R above Shroder	R adjacent below Shroder; R above Shroder
8	--	--	37.14	--	2,430	9	0	1.4	-37	0.36	L adjacent lower; crosses at Bend; R adjacent and R upper	R adjacent
7	--	--	15.56	--	750	0	0	0.5	-16	3.98	L	L lower; crosses below Big Rock Creek; R upper
6	2.9	0.028	25.54	--	0	0	0	0.1	-1	-1.08	L	L
5	--	--	45.16	--	1,875	0	0	1.6	-10	-2.68	R lower; crosses above Bear Creek; L upper	R lower; R adjacent upper; crosses at Chippy Creek
4	-6.2	-0.039	15.43	+0.748	12,300	16	4	16.1	-32	1.63	R	L adjacent below Little Thompson River; R adjacent above
3	-0.6	-0.018	18.58	--	12,675	18	2	6.7	-19	0.83	R adjacent	L adjacent
2	-1.1	-0.004	15.77	-3.789*	19,890	32	6	23	-44	-4.85	R adjacent	L adjacent
1	-3	-0.026	11.28	--	8,610	0	0	7	-30	0.74	R adjacent	L adjacent except lower 1 mile
				*Based on partial remnant XS								

3. Bank Condition

Over 44 miles of the Thompson River were evaluated for stream bank condition. Each bank segment was classified into one of nine bank condition categories. Bank erosion hazard indexes (BEHI) were calculated for a sample of each category. BEHI values indicate erosion potential

Most (78%) of the surveyed banks along the Thompson River have low erosion potential. Most bank erosion occurs where there has been bank hardening resulting from a lack of vegetation, shallow root densities, and steep slopes. Of the 12 miles (14%) of hardened bank, 10.7 miles (28%) are in Reaches 1, 2, 3, and the lower half of Reach 4 (below mile 18). Only 1.3 miles (2.5%) of hardened bank occur above mile 18. Roads are within 30 feet of 13.5% of banks. Bank hardening inhibits natural riparian vegetation along 9% (8.3 miles) of bank.

4. Riparian Vegetation

The riparian area boundary of the Thompson River was delineated for this assessment and vegetation communities were identified within the riparian area based on the dominance of tree, shrub, or herbaceous species. Potential and existing riparian vegetation areas were identified. The report includes information about the existing riparian area composition, trends evident from reviewing historical aerial photographs, and riparian area impacts and related effects resulting from roads.

Of the total potential riparian vegetation area mapped for the Thompson River corridor (1928 acres), 3.2% (61.9 acres) are currently occupied by roads. Of those 61.9 acres, 77% (47.7 acres) occur in Reaches 2-4; 45% (27.9 acres) in Reach 2, 12% (7.5 acres) in Reach 3, and 20% (12.3 acres) in Reach 4.

Roads have impacted riparian vegetation communities in several direct ways, including:

- vegetation removal from the riparian area
- import of fill material into the riparian area
- direct sedimentation into the riparian area
- altered hydrologic connection between the riparian area and adjacent uplands
- confinement and occasional entrenchment of the river and its resulting effects on riparian vegetation processes
- elimination of the riparian area in cases where the river is confined between both roads
- isolation of historical riparian areas and conversion to a different wetland type

5. Large Woody Debris Recruitment

A large wood recruitment zone is defined as a 120-foot extension of the flood prone area. This distance (120 feet) is an approximation of the height of a mature tree in the Thompson River watershed and corresponds to the distance from the flood prone boundary. If a tree falls into this flood prone area, it could still potentially reach the channel by being picked up during flood events.

The LWD recruitment area constitutes over 1,175 acres. Almost 15% (180 acres) of the LWD recruitment zone is currently occupied by roads. Seventy-nine percent of that (141.4 acres), occurs in Reaches 1-4; 17% (30.9 acres) in Reach 1, 28% (51.0 acres) in Reach 2, 23% (40.6 acres) in Reach 3, and 11% (18.9 acres) in Reach 4.

The area of tree-dominated communities in the large wood recruitment zone of the Thompson River has decreased over time due road construction, logging, and land clearing. Altered flood flows as a result of road impacts to the river may reduce the floodplain area accessible by the river during flood events and thereby reduce large wood recruitment. Conifer regeneration is occurring in many of the logged and/or grazed areas within or adjacent to the large wood recruitment zone, although altered flood flows will continue to limit large wood recruitment and regeneration will continue to be excluded from open roads.

6. Wetlands Delineation

Wetlands occur throughout the Thompson River corridor. Wetlands occur both in the riparian area of the Thompson River and outside of the riparian area, along the existing roadways. Wetlands in the riparian area tend to be associated with groundwater upwelling, most likely from the river channel. Wetlands outside the riparian area tend to be associated with ground water sources outside of the Thompson River floodplain. These tributaries or slope wetlands are often fed by springs.

Overall wetland acreage may be decreasing over time with loss of vegetation to hold ground water in the upper layers of the soil. The composition of wetlands has changed over time with the loss of forested and scrub wetlands and an increase in emergent wetland. Wetlands may have also been created over time from runoff in roadside ditches. Wetlands may also be created as a result of roadways restricting hydrologic connectivity to the river.

Wetland delineation identified over 76 acres of wetlands along the Thompson River corridor as well as approximately 270 acres of hydric soils. Most of the wetland area occurs in Reaches 2, 4, 6, 8, and 10. Large areas of hydric soils occur in Reaches 4-10.

7. Road Sediment Delivery

Over 74 miles of road (Route 56 and 9991), including 55 drainage crossing structures, were evaluated for road surface erosion and sediment delivery. Generally, less than 1 pound of sediment per foot of road is contributed annually to the Thompson River from road segments. Additional sediment is contributed at stream crossings. Road segments within 300 feet of the river contribute more sediment than stream crossings.

Overall, the road sediment analysis identified 41 contributing sources of road sediment. Most sediment contribution from road surface erosion occurs in Reach 1, with lesser but notable amounts in Reaches 2, 3, and 9 (Table 2). Refer to the road sediment analysis report and associated shapefile for details and specific source locations.

8. Riparian Shade

Overall percent of stream with shade from riparian vegetation was determined by the occurrence and type of riparian vegetation mapped in the riparian vegetation analysis as well as the density and distance of vegetation to the stream edge. Just over 21% of the Thompson River receives shade from riparian vegetation. Reaches with a larger percent of riparian shade include Reaches 3 and 5-10. In general, reaches most influenced by roads have the least riparian shade: Reaches 1, 2, and 4 have 10% or less.

9. Road Contaminants

A road contaminants survey was completed on Route 56 at the residential town sites of Copper King (Reach 2) and Snider (Reach 2). In the past, road dust abatement practices included spraying diesel and other petroleum-based constituents on the road surface to reduce airborne dust. This practice has been curtailed in favor of treating the road surface with other less toxic dust abatement products including calcium chloride. The goal of the Thompson River Corridor Road Contaminants Analysis and survey was to determine the presence of petroleum constituents in roadbed materials, the depth of petroleum constituents below the roadbed surface, and the concentration and type of petroleum contaminants.

Over time, these products have migrated to the road sub-grade via road grading and gravity leaching. Petroleum contamination of the Route 56 sub-grade soils was evident at both assessment sites. Contamination levels and ranges are similar at both sites. Several sub-samples in both sites exceed the State standards for extractable petroleum hydrocarbons. One sub-sample in each site exceeds State standards for aromatic petroleum hydrocarbons.

10. McNeil Cores

The goal of the McNeil core survey was to evaluate fine sediment concentrations at select locations based on the degree of road-channel interaction in the Thompson River. Sampling locations were stratified into five categories based on the degree of road-channel interaction. The McNeil core survey intended to quantify and compare fine sediment concentrations in potential spawning locations in the main stem Thompson River with sampling locations stratified according to road proximity to the channel.

The McNeil core analysis of streambed substrate suggests the benefits of fewer roads adjacent to streams, of roads that do not encroach on streams, and of the effectiveness of riparian buffers on reducing contribution of fine sediment to streams. Sites with a road at a distance (> 300' buffer) and sites with a road encroaching on the same side as a functioning floodplain have the lowest percent fines (Table 10). Sites with a road encroaching on one or both sides without floodplains had the highest percent fines. Characteristics of reaches that were not sampled were extrapolated from the results of sampled reaches (Table 10).

11. Stream Crossings

A total of 32 stream crossings by Routes 56 and 9991 were evaluated for fish passage and risk of culvert failure. Twelve of the crossings on major tributary streams were considered capable of bearing fish. All of these crossings were determined to be barriers to fish passage between the Thompson River and the tributaries, although 4 have natural barriers just upstream of the structures. Of those 4, electro-fishing in 2 of the 4 tributaries with natural barriers confirmed the effectiveness of the barriers as no fish were found above the obstacles. Of the 8 human-caused fish passage barriers, 4 occur on Route 56, blocking 10.5 miles of useable upstream habitat. The other 4 barriers occur on Route 9991, blocking 23 miles of useable upstream habitat. Both Semem Creek crossings would need to be replaced to provide access to all 2.7 upstream miles of habitat. Combined, there are over 33 miles of useable upstream tributary habitat that currently are not available to most fish in the Thompson River system. This unavailable habitat is important refugia from the warm Thompson River water, and could also provide important, high-quality spawning and rearing habitat which the Thompson River currently lacks. Priority crossings were determined to be: Goat (56), Bay State (9991), Deerhorn (56), Chippy (9991), and Semem (56 and 9991). (Deerhorn and Chippy Creek crossings are currently under design for replacement with fish-passable structures).

Fourteen crossings were undersized such that the headwater-to-depth analysis suggests a risk of crossing structure failure and possible sediment contribution of road fill at Q2 discharges. Total fill from the 14 at-risk crossings is estimated to be 2,354 tons. Most fill is associated with 3 crossings: Goat Creek (933 tons), Big Hole (252 tons), Deerhorn (419 tons), and Tributary 8 downstream of Meadow Creek confluence (419 tons).

At least 8 structures along Routes 56 and 9991 were not analyzed for fish passage capabilities. It is generally believed that these structures do not impede fish passage. However, some of these structures are likely undersized to some degree, constricting both the channel and floodplain, and may require increased maintenance.

12. Aquatic Habitat

Habitat surveys were conducted along 33 miles of the Thompson River, from the confluence with Shroder Creek to the confluence with the Clark Fork River. Approximately 11.7 miles of the Thompson River were surveyed. Measured habitat parameters include habitat type, spacing, and dimension as well as woody debris, bank stability, side channel habitat, and percent surface fines.

Of the habitat parameters measured, most do not meet reference conditions. All reaches are well below (insufficient) the INFISH Riparian Management Objective (RMO) for pool frequency. Increasing number of pools in the upstream direction coincides generally with fish population. It also coincides with the general influence of roads (more influence 0-18 stream miles; less influence above mile 18). Pool area values are low overall, and more so where there is less road influence (and less stream power from road encroachment). There is a high number (56% of reaches) with good quality pool volume to width ratios when compared to the reference. There

are also larger pools in lower reaches with more road influence, possibly resulting from more stream power from road encroachment.

Overall, there is a lack of large woody debris (LWD); there is significantly more LWD in the upper 15 miles with less road influence than in the lower 19 miles. Lack of LWD in the lower reaches is a result of road impact on riparian/LWD recruitment and is attributed to grazing on riparian/LWD recruitment in the upper reaches.

Width/depth in most reaches (82%) is greater than reference conditions. Width/depth values are significantly lower where there is less road influence. A larger proportion of reaches have eroding banks, although there is no apparent difference related to road influence. Most reaches contain undercut banks, although less so in the lower 18 miles where there is more road influence. Rip rapped road fills are a difficult medium for creating undercut banks because they are designed specifically to prevent such undercutting. Also, there is greater bedrock influence in the lower reaches, which also prevents undercutting.

Overall, percent surface fines as measured by grid tosses are low; 27% of reaches are in excess of reference conditions. Total side channel habitat area seems to be low overall relative to the range within the sample, although there is no reference for comparison. On average, amount of side channel habitat is greater above mile 16. Finally, there is a generally equal distribution of side channel habitat among reaches.

13. Fish Populations

Along with the habitat surveys described above, snorkel surveys were conducted along 33 segments of the Thompson River from the mouth up to Shroder Creek. Fish observed during the survey were directly enumerated to determine relative fish abundance by species and size/age class.

Native salmonids occur in low numbers in the Thompson River and their distribution is also limited (bull trout in 18% of habitat units surveyed and west slope cutthroat in 6%) (Table 9 and Figure 13). Native salmonids do not exist above stream mile 21. Native suckers are also limited to 13% of surveyed habitat units. Native mountain whitefish are abundant and occur in 94% of habitat units surveyed. Non-native fish are common and widely distributed throughout the Thompson River: rainbow trout were found in 93% of surveyed units, mostly from stream mile 1-23, and brown trout in 81% of units, mostly from stream mile 20-33. Brook trout were only found in the upper 5 miles of the survey.

Prior to surveys conducted in the summer of 2008, fish data in surveyed tributaries indicated densities that were very low, especially for native fish. No bull trout were found in the tributaries and west slope cutthroat trout were found only in Big Hole Creek, although native fish are known to occur higher up in tributary drainages.

During the summer of 2008, electroshocking and snorkel surveys identified populations of native fish in 6 tributaries to the Thompson River (Alder, Big Rock, Chippy, Little Thompson, McGinnis, and North Fork Little Thompson Creeks). West Slope Cutthroat Trout were the most

prevalent and were found in all of the tributaries listed. Bull Trout were found in Alder and Big Rock Creeks and Montana Whitefish were identified in Chippy and Little Thompson Creeks.

Highest fish densities in the Thompson River were found above stream mile 18, where the impact from the dual road system is less than in the lower drainage; however, the relationship is not statistically significant. Most fish are small (< 300 mm) juveniles. The greatest sinuosity (channel length) and greatest percent pools are found in Reach 5 where the highest fish density is found.

Table 9. Summary of fish population density (fish/100m ²) based on surveys in the Thompson River.									
Reach	Rainbow Trout	Brown Trout	Brook Trout	Non-native Fish	West Slope Cutthroat	Bull Trout	Whitefish	Sucker Species	Native Fish
10	Not surveyed								
9	Not surveyed								
8	2.2	2.2	2.2	6.5	0.0	0.0	27.0	0.0	0.0
7	1.3	4.3	0.2	5.8	0.0	0.0	17.2	0.0	0.0
6	5.8	11.1	0.0	16.9	0.0	0.0	8.9	0.0	0.0
5	1.3	2.5	0.0	3.8	0.2	0.0	2.9	0.0	0.2
4	6.0	0.5	0.0	6.4	0.0	0.0	0.9	0.0	0.0
3	7.5	0.9	0.0	8.4	0.0	0.1	8.4	0.0	0.1
2	18.2	1.1	0.0	19.3	0.1	0.2	16.8	0.2	0.3
1	3.1	0.4	0.0	3.5	0.0	0.1	16.2	0.8	0.1

There is a notable difference in fish species distribution above and below mile 15, near Fishtrap Creek (Figure 12), which coincides with a possible temperature barrier as well as a difference in habitat characteristics. Rainbow trout are the dominant trout species in the lower section where water temperatures are colder, whereas brown trout are the dominant trout species in the upper section where temperatures are warmer. Brown trout are more tolerant of warmer temperatures than rainbow trout and native trout species such as bull trout and west slope cutthroat trout.

Possible factors contributing to warmer temperatures upstream include: a potentially shallow aquifer, limited riparian shading, wider valley (more incident solar radiation throughout the day), discharge of warm water from the Thompson Lakes, and possibly warmer discharge from various tributaries. Below mile 15 at Fishtrap creek, bedrock control may be pushing colder groundwater to the surface. Riparian shading is still limited but the narrower valley receives less incident solar radiation throughout the day. There is possibly more input of cold water from major tributaries such as Fishtrap and West Fork of Thompson River.

As described in previous sections, surveyed aquatic habitat does not meet reference conditions and is likely in a declining trend based on geomorphic analysis. Pool and large woody debris

measures are low and width/depth ratios and percent fines are high, all of which can negatively affect fish populations.

The overall low number of native salmonids within the Thompson River results from a lack of quality aquatic habitat, elevated water temperatures, and competition and displacement of non-native species. Much literature has shown that non-natives thrive in degraded habitat conditions (higher temperatures, less riparian vegetation, more fine sediment, fewer quality pools, etc.) whereas native species tend to decline. The dual road system along the Thompson River has contributed to these habitat conditions.

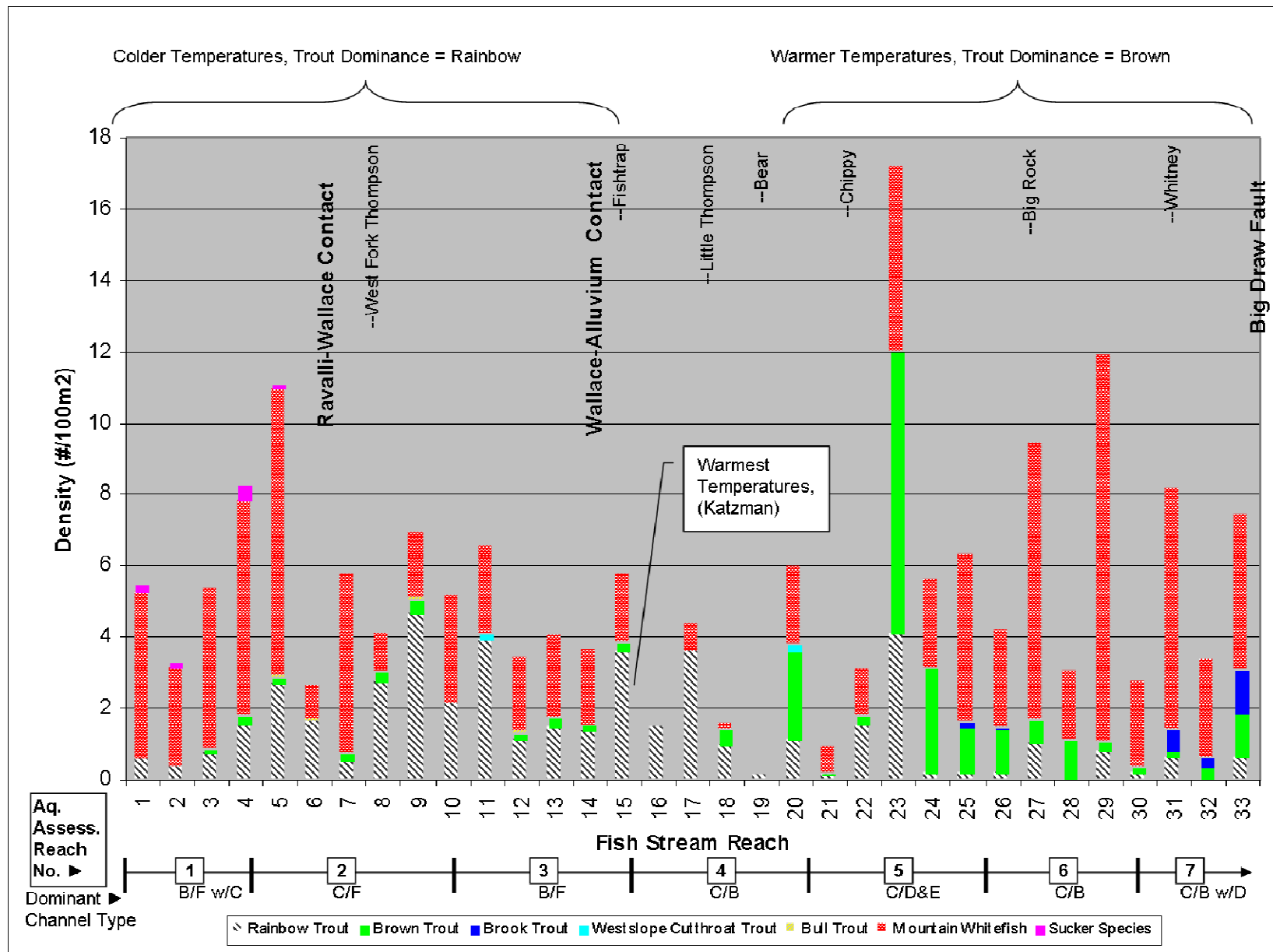


Figure 13. Fish density by surveyed reach with associated geomorphic features.

14. Fish Angling/Recreation (Creel Survey and Angler Access)

A creel survey was conducted to determine, as a baseline, the magnitude and distribution of existing fishing efforts. A mail survey was also conducted to determine potential effects to fishing access and accessibility of the river to anglers. Results of both the mail and creel surveys help to determine future fishing access opportunities, as well as opportunities to increase accessibility of the river to anglers.

Most **creel survey** and angler use information was analyzed for two sections, the lower section below mile post 17 bridge (the canyon) and the upper section, above mile post 17 bridge (the wider, glaciated valley).

As discussed previously, the warmest measured temperatures are upstream of Fishtrap confluence and downstream of the Little Thompson confluence. Cooler temperatures in the lower section help foster the primarily rainbow trout fishery in the lower section. Warmer temperatures in the upper section help sustain the primarily brown trout fishery. This is corroborated by the fish distribution/density information collected during snorkel surveys by the Lolo National Forest. There is also an increase in the number of pools per mile above mile 20 (fish habitat survey) although higher pool quality (more pool volume/width) and somewhat more side channel habitat exists below mile 20.

The creel survey revealed that 75% of fishing pressure occurs in the lower section. For both sections, little pressure occurs in the fall or winter and most occurs in the spring and summer. In the lower section, most pressure is on weekdays while in the upper section, most pressure occurs on weekends/holidays. Most anglers are fishing for trout in general and 80% of the reported catch was trout. Catch in the lower section consists primarily of rainbow trout, whitefish, and west slope cutthroat trout; catch in the upper section consisted primarily of brook and brown trout. This corresponds with fish population survey findings described previously.

Other findings of the creel survey include:

- Almost all fishing occurs from bank and wade fishing rather than from boats.
- Most anglers park in pullouts. Others park along the shoulder of the road or at camp sites. Most of the camp site parking is accessed from Route 56. Overall, most anglers used Route 9991 rather than Route 56.
- Recorded non-angler use occurred mostly in the upper section and use camping areas for parking. Most non-anglers use Route 56 rather than Route 9991.
- Parking locations used by more than 10 anglers along Route 9991 include: the mouth, miles 0.7, 3.1, 4.2, 11.3, 11.7, 16.2, 17.3, and 26.9 (bridges, pull-outs, and a camping area). Most of these sites are below mile 18.
- Parking locations used by more than 10 anglers along Route 56 include: 1.1, 1.2, 3.9, 4.0, 6.4, 8.2, 9.2, 9.3, 10.2, and 14.8 (pull-outs and camping areas). All of these sites are below mile 15.

-
- Fished locations generally overlapped the parking locations.
 - More than 10 non-anglers park at miles 21.2 and 34.6 (camping area and bridge) on Route 9991, and 14.8 and 31.9 on Route 56 (camping, confluence, road intersection).

Results from the **mail survey** are similar to the results of the creel survey (i.e. most anglers use the lower section). Why most anglers use the lower section is not readily known, but several possible reasons may include: the proximity of the lower section to town (Thompson Falls), two roads near to the river providing increased opportunities for access, greater opportunities for access via public lands, and colder water in the lower section providing more opportunities for catching the most sought after fish (rainbow and cutthroat trout).

The results of the mail survey can be summarized by the following points:

- Maintain access for most-used (lower) section.
- Allow parking on shoulders and more pullouts.
- Maintain access on both sides of the river via footbridges and walking/hiking trails on the “non-roaded” side.
- Maintain or improve access safety.
- Maintain primitiveness.
- Provide for overnight camping, day use only, and possibly some RV use.
- Maintain bridge access.

Other points from the mail survey include:

- Respondents did not feel access for boating or swimming was important (although most respondents were non-boating, non-swimming anglers).
- Most were concerned with having a single road, especially one that is paved, because of increased speed, traffic use, congestion, crowding, pollution, fishing pressure, and lack of access to the other side.
- Angling pressure on the Thompson River is currently low when compared to other western Montana rivers, but is increasing.
- Angling on the Thompson River is highly popular within the MFWP northwest region.
- Low flow during the survey year (2005) may have accounted for fewer than normal boaters, and more than normal anglers (a result of high water clarity). Alternatively, fishing closures resulting from high temperatures may have resulted in fewer anglers.

15. Summary assessment of current conditions and proposed alignments

In summary, this evaluation assessed the existing conditions of the aquatic and hydrologic resources along the Thompson River corridor and in particular the affects of the existing dual road system. Fishing use was also monitored. In addition, the assessment has evaluated the potential impacts and benefits of proposed alignments for a Thompson River Forest Highway route as well as of possible decommissioning of the surplus route. The following summary recaps the existing conditions, geomorphic trends, and current habitat status. Benefits and impacts of the proposed alignments are compared and contrasted. Restoration/rehabilitation opportunities and needs are described in the next section.

Existing Condition (Table 2)

Channel morphology analyses evaluated several parameters. Width/depth measurements reveal wider, shallower than expected channel conditions, especially in altered reaches. Evidence of channel incision is limited, suggesting vertical stability which, in the lower sections, results from bedrock control. Evaluation of entrenchment ratios suggests impacts to the Thompson River have resulted in decreased floodplain access and increased effects to riparian and channel characteristics. A comparison of meander cutoffs with the existing channel suggests localized incision as well as changes in stream power, although wide-spread incision has not occurred. All of these measures affect riparian and aquatic habitat. Converting the dual road system to a single road would provide opportunities to reduce existing impacts and restore/rehabilitate the channel to allow for a more functional channel and floodplain hydrology.

From the summary of existing conditions presented in Table 2, the greatest percent of **streambanks** with moderate, high, or very high bank erodibility rating occur in Reaches 1-4 with much lower percentages in Reaches 6-10. Bank erosion is mostly associated with bank hardening which occurs in the lower reaches. Eliminating one of the existing roads and removing bank/fill armoring would provide opportunities for reducing impacts and permit the rehabilitation of natural channel, bank, and riparian functions.

The greatest proportion of **riparian area** occupied by roads also occurs in Reaches 1-4. In general, the further away the roads are from the riparian area, the fewer effects there are on riparian function. Portions of Reaches 5 and 6 are isolated from roads and support broader, more diverse riparian plant communities.

The Preferred Alignment would result in less potential riparian area impact (5.0 acres) and more riparian area with road removal (39.2 acres) in Reaches 1-4 than the Secondary Alignment (7.7 acres impacted and 15.1 acres of road removal) (Table 10). For Reaches 5-10, the Secondary Alignment would have less impact (0.8 acres) and greater potential for removing road (9.8 acres) from riparian areas than the Preferred Alignment (3.9 acres impacted and 2.6 acres of road removal).

The **large wood recruitment** zone is based on proximity to the flood prone area, which roughly coincides with the riparian area. Roads in the riparian area are impacting large wood recruitment potential resulting from the removal of trees when the road corridor was originally created, continued maintenance of the road corridor, and altered flood flows. The greatest impact to the

LWD recruitment area occurs in Reaches 1-4 where road impacts to the riparian area are also greatest.

The Preferred Alignment has slightly less potential overall for impacting LWD recruitment than the Secondary Alignment (19.1 versus 19.6 acres), and also has greater potential for removing road from the LWD recruitment zone (96.5 versus 86.2 acres) (Table 10). The Preferred Alignment would be better for reaches 1-5 (83.6 versus 68.2 acres) whereas the Secondary would be slightly more beneficial for Reaches 6-10 (18.1 versus 12.9 acres). Otherwise, most opportunities for restoring LWD recruitment involve altering land management activities (grazing, agriculture, silviculture, etc).

The **wetland** delineation analysis suggests that the Secondary Alignment would, overall, have the least amount of new impact to existing wetlands (1.2 acres) and the greatest potential improvement to the wetland resource by removing roads from wetland areas (3.1 acres) than impacts and removal with the Preferred Alignment (1.3 and 2.2 acres, respectively) (Table 10).

With the Preferred Alignment, very little current or potential impacts or improvements to wetlands would occur in Reaches 1 and 5. For Reaches 4 and 6, there would be a smaller impact to wetlands and greater potential for the removal of road from wetlands under the Preferred Alignment. In Reach 10, there may be greater impact (0.4 acres) than there would be road removed from wetlands (0.2 acres). For the remaining reaches, there is very little difference (equal impact versus removal of road or ≤ 0.1 acre change) with the Preferred Alignment.

With the Secondary Alignment, there would be little to no change (≤ 0.1 acre change) between the existing condition and the proposed alignment for Reaches 1, 3, 5, 7, 8, and 10. In Reaches 2, 4, and 9 there would be less new impact to wetlands than there would be area of roads removed from wetland areas, potentially resulting in a total wetland area increase of 1.4 acres. In Reach 6, there would be more impact to wetlands than there would be removal of road from wetland areas.

Most sediment contribution from **road surface erosion** occurs in Reach 1, with lesser but notable amounts in Reaches 2, 3, and 9. The amount of sediment from existing road surface erosion is not a very good indicator of which route should be selected. Instead, road sediment values indicate the relative need to address BMPs and mitigation measures at specific locations.

Overall, the Thompson River receives about 21% shade from riparian vegetation. Reaches with the greatest road influence receive 10% or less **riparian shade**. The Preferred Alignment, with no changes in road width, would likely result in a greater overall increase in riparian shade (Reaches 1-5) with no change in Reaches 6-10 (Table 10). If the road width is going to be expanded, then the Secondary Alignment would likely result in a greater overall increase in stream shade (Reaches 1-3 and 6-9). With either alignment, whether the selected route is widened or not, there will be little change ($< 1.6\%$) in percent riparian shade in Reaches 5-10. One exception is in Reach 9, which would have a 2.7% increase. The greatest potential changes would occur in Reaches 1-4. Whether the road is widened or not, the Preferred Alignment would result in the greatest potential increase in stream shade in Reaches 1, 2, and 4. The Secondary Alignment would have the greatest percent increase in Reach 3.

The largest amounts of fill at risk of failure from **undersized crossings** occur in Reaches 1, 2, 3, and 8. Large amounts of habitat are unavailable above these undersized crossings, and also above crossings in Reach 5, 6, and 8.

The Preferred Alignment would consist of 7 River crossings and 9-10 major tributary crossings, whereas the Secondary Alignment would consist of 7 river crossings and 7 major tributary crossings (Table 10). However, if crossings are designed and implemented to meet standards for passing Q100 flows and accommodating aquatic organism passage at multiple stages, then the absolute number of crossings may not be a resource issue other than for infrastructure, maintenance, and sediment contribution from road surface erosion (if left unpaved).

Sampling of Route 56 road bed material in Reaches 1 and 2 confirms petroleum contamination which exceeds State standards. Further analysis should examine the risk of this contamination spreading, additional locations of contamination, and methods for remediation. **Road contamination** should be addressed in Reaches 1 and 2, and elsewhere if applicable.

The data suggest that fine sediment concentrations in portions of the Thompson River could negatively effect egg survival and fry emergence in reaches impacted by fine sediment delivered from the road network. The largest percent of **channel substrate fines** were found in Reaches 2 and 3 (where road encroachment is greatest), with lower percent fines in Reaches 4 and 7.

Reducing fine sediment delivery to the channel network would be expected to improve water quality, aquatic habitat conditions, and spawning quality over time. Possible ways to decrease fine sediment delivery include reducing road density in the watershed, increasing the width of riparian areas buffering the river network from the road network, and better managing road maintenance activities.

Geomorphic Trends (Table 8)

The greatest and most direct influence of the dual road system occurs in Reaches 1-4. This influence is in the form of reduced channel length, decreased sinuosity, greatest length of encroaching road, greatest number of meander cut-offs and truncations, greatest percent of floodplain with road prism in it, and large decrease in mean belt width. Reaches 8 and 9 also have a notable number of cut-off meanders, percent of floodplain occupied by road, and a decrease in mean belt width. Overall, total bar area has decreased over time, suggesting increased sediment transport out of the system.

Habitat Analysis and Fish Populations

Habitat parameters do not meet desired conditions. There is a statistically significant difference between the number of pools per mile in stream reaches influenced by road (Reach 1 through the lower half of Reach 4) and those less influenced (upper half of Reach 4 through Reach 10). There are almost three times as many pools in reaches less influenced by road. This demonstrates the impact road influence is having on aquatic habitat and suggests that decreasing road influence (by removing road influence) may result in increased pool frequency and therefore promote habitat improvement. (Although generally the pools present are high quality, e.g. deep).

Similarly, there is significantly less LWD in stream reaches influenced by road than those less influenced, although LWD numbers are generally low throughout the Thompson River when compared to reference conditions. Furthermore, the greatest proportions of potential LWD recruitment areas occupied by road also occur in Reaches 1-4 (Table 2).

Width/depth ratio measurements are greater than reference conditions in most reaches and are significantly lower where there is less road influence. Side channel habitat is also limited, although more occurs upstream of mile 16 than downstream.

Species distribution indicates that habitat conditions favor colder water species in the lower reaches and warmer water species in the upper reaches. Water temperatures are likely influenced by geology, groundwater hydrology, channel morphology, stream shade, and habitat such as pools and LWD.

Theoretically, the channel types found in the lower portion of the corridor are more stable and should provide better habitat. However, habitat and fish populations are greater in the upper half of the corridor where there is less road influence. Owing to the influence of roads in close proximity to either side of the river, even the inherently stable lower river sections are negatively impacted. The upper section consists of less stable channel types and erodible bank materials, but because the valley is wider and road encroachment is less, the road systems are less of an influence; these upper sections have not been impacted as greatly.

Based on the existing conditions summarized in Table 2, geomorphic trends summarized in Table 8, and the habitat analysis findings, it is clear that roads have a measurable affect on the aquatic and hydrologic properties of the Thompson River.

Fish Recreation

The results of the creel and mail survey can be summarized by the following points:

- Frequent access points are needed between the mouth and river mile 19 for maintaining current angler use.
- Not as much access is needed from mile 19 to 39 as in the lower section, but a few select spots in the upper section are well-used.
- It is important to develop/maintain access at bridges and camping areas as well as maintain parking areas and pull outs.
- Where road segments are removed, providing access via trails and foot bridges is also important.
- Non-angler/angler use does not overlap, so access for other users in other locations is also important.
- Concentrating access and fishing pressure from a single road is a concern.

Table 10. Summary of alignment comparison. (Shading indicates greatest improvement and/or least impact. Cross hatching indicates presence.)

Reach	Riparian Vegetation Area (acres)				Large Woody Debris Recruitment Zone (acres)				Wetlands (acres) (+removal – impact)		Riparian Shade (percent)				Road Contamination Presence	Number of River Crossings (Major Tributary Crossings)		McNeil Cores % Fines		
	Preferred Alignment Potential New Impact on Riparian	Preferred Alignment Potential Road Removal from Riparian	Secondary Alignment Potential New Impact on Riparian	Secondary Alignment Potential Road Removal from Riparian	Preferred Alignment Potential New Impact on LWD Zone	Preferred Alignment Potential Road Removal from LWD Zone	Secondary Alignment Potential New Impact on LWD Zone	Secondary Alignment Potential Road Removal from LWD Zone	Preferred Alignment	Secondary Alignment	Preferred Alignment (no width change)	Preferred Alignment (wider road)	Secondary Alignment (no width change)	Secondary Alignment (wider road)		Preferred Alignment	Secondary Alignment	Preferred Alignment	Secondary Alignment	
10	1.4	0.5	0.1	3.5	1.2	3.1	0.6	6.5	-0.2	+1.0	0.0	0.0	0.0	0.0		1 (0)	0 (0)			
9	0.8	0.2	0.2	2.3	0.6	4.6	0.9	6.0	LNC	+ 0.3	0.0	-1.2	+2.7	+2.7		0 (0)	1 (0)			
8	0.8	0.3	0.1	1.7	0.7	0.5	0.1	3.2	LNC	LNC	0.0	-1.0	+1.4	+1.4		0 (2)	1 (0)			
7	0.3	0.8	0.3	1.0	0.2	4.5	0.8	1.5	LNC	LNC	0.0	0.0	+0.5	+0.4		1 (0)	0 (1)			
6	0.2	0.0	0.0	0.2	0.4	0.2	--	0.9	+0.7	+ 0.8	0.0	-0.7	+0.8	+0.8		0 (1)	0 (1)			
5	0.4	0.8	0.1	1.1	1.0	3.7	1.7	2.5	LNC	LNC	+1.6	+1.4	+0.2	-0.3		1 (1)	1 (1)			
4	0.3	11.3	2.2	1.1	0.8	14.7	2.9	4.3	+0.5	- 0.5	+7.1	+7.1	0.0	-2.1		0 (1)	1 (1)			
3	0.8	6.1	1.3	1.7	4.7	19.1	3.3	22.6	LNC	LNC	+4.7+	+2.9	+6.2	+5.0		1 (0)	1 (2)			
2	3.3	19.7	3.5	11.2	7.6	26.1	5.2	27.4	LNC	+0.3	+5.7	+4.7	+5.4	+3.5		2 (2-3)	1 (0)			
1	0.6	2.1	0.7	1.1	1.9	20.0	4.1	11.4	LNC	LNC	+4.0	+3.9	+2.7	+1.7		1 (2)	1 (1)			
Total	8.9	41.8	8.5	24.8	19.1	96.5	19.6	86.2	-1.3 impact +2.2 removal	-1.2 impact + 3.1 removal	+2.6	+2.0	+2.2	+1.3		7(9-10)	7 (7)			
									LNC = Little/No Change									Interpretations based on number of roads and proximity.		

Proposed Alignments (Table 10)

One of the purposes of these assessments was to compare the potential affects of the two proposed highway alignments. In doing this, a primary assumption in each analysis was that the alignment which is not selected will be decommissioned and the road bed will not continue to impede functions such as LWD recruitment, stream shade, floodplain access, etc. For further method descriptions, assumptions, and other details, refer to the appropriate individual report.

Overall, the Preferred Alignment would have the greatest benefit to increasing riparian area (41.8 versus 24.8 acres), large woody debris recruitment (96.5 versus 86.2 acres) and riparian shade (1.3-2.2 versus 2.0-2.6 acres).

The Preferred Alignment would result in almost 40 acres of road removal from the riparian area in Reaches 1-4. In Reaches 5-10, the greatest benefit is associated with the Secondary Alignment with almost 10 acres of road removal from the riparian area. Either alignment would have some new impacts associated with road widening. However, new impacts are relatively small when compared to potential benefits from road removal. Large woody debris recruitment and riparian shade would be affected similarly as these parameters are directly related to the amount of functioning riparian area.

Overall, the Secondary Alignment would provide for the least amount of wetlands impact and greatest removal of road from potential wetland areas. The benefits would occur in Reaches 2, 4, 6, 9, and 10. With the Preferred Alignment, benefits would also occur in Reaches 4 and 6, but would be slightly less than the Secondary Alignment.

Results of the McNeil core analysis suggest that the percent of substrate fines is higher where road influence is greater (in closer proximity to the stream). Based on stream proximity by reach of the proposed alignments, the Secondary Alignment would result in lower fines in Reaches 1, 3, and 8-10 while the Preferred Alignment would have less affect on fines in Reaches 4 and 7. There is little to no distinction between the effects of alignments in Reaches 2, 5, and 6. However, sediment delivery can and should be addressed by appropriately identifying, implementing, and maintaining best management practices to reduce fine sedimentation.

A larger number of river and tributary crossings would exist in Reaches 1-4 with the Preferred Alignment as compared to the Secondary Alignment. With new Aquatic Organism Passage standards required by Forest Service Region 1, these crossings would be designed to minimize road influence and maintenance, maximize safety, and have the least possible impact to organisms.

Based on the results presented in Table 10, the greatest benefit to the hydrologic and aquatic resources of the Thompson River would include a combination of the proposed alignments (Figure 19; also refer to the shaded cells in Table 10). Specifically, the greatest benefit would be provided by the Preferred Alignment in Reaches 1 - 4 and the Secondary Alignment in Reaches 5-10. The preferred alignment corresponds with keeping Route 56 in Reach 1 and the lower half of Reach 2, Route 9991 in the upper half of Reach 2, Route 9991 in Reach 3, and Route 56 in Reach 4. The Secondary Alignment in Reaches 5-10 consists of keeping Route 56 and eliminating Route 9991.

The greatest potential for removal of road within the riparian area, LWD zone, and areas providing riparian shade would occur with the Preferred Alignment in Reaches 1-4. In Reaches 5-10, the greatest potential for removal of road from within the riparian area, LWD zone, and areas providing riparian shade would occur with the Secondary Alignment. There would be little to no change in wetlands resource for either alignment in Reaches 1-4. In Reaches 5-10, the greatest benefit for wetlands would occur with the Secondary Alignment. Other factors (road contamination, stream crossings, and percent fines) can be addressed independently of alignment selection by removing contamination, replacing crossings with adequate structures, and addressing road BMPs, respectively.

16. Restoration Opportunities and Stream Rehabilitation Needs

Opportunities Independent of Road Alignments

There are likely several areas where constructing/reconstructing a bankfull elevation bench stream-ward from road fills could result in establishment of more riparian vegetation; increase sediment buffering, stream shade, and LWD recruitment; and reduce the need for hardened bank armoring with rip rap. Doing so may also reduce width-to-depth ratios and could include the addition of LWD for improved habitat. Identifying these opportunities would require further field reconnaissance.

Numerous meander cut-offs and truncations exist along the Thompson River and the dual road system. Multiple opportunities to reconnect meanders and/or restore hydrology to depleted wetlands exist. Four obvious meander/meander sequence reactivation opportunities include:

- 2 meanders at the bottom of Reach 2, between milepost 4.5 and 5.0 (Figure 14; See also Figure 4 in Channel Morphology Analysis report).
- 2 meanders at the bottom of Reach 4, between milepost 15 and 15.5 (Figure 15)
- 1 meander near the bottom of Reach 4, near milepost 16 (Figure 16)
- at least 6 abandoned meander wavelengths at the lower third of Reach 9, below Shroder Creek and just upstream of the Bend area (Figure 17)

These restoration opportunities could be accomplished regardless of which single alignment is selected or if neither is selected. The first 3 meander reactivation opportunities listed above would be best accomplished along with the Preferred Alignment option. The benefits of meander reactivation in Reach 9 would be greatest in combination with the Secondary Alignment.

Benefits of meander reactivation are similar to creating bankfull elevation benches. In addition, meander reactivation would increase stream length and sinuosity, thereby increasing the amount of habitat available (Figure 14).

Reactivating the 2 meanders at the bottom of Reach 2, between milepost 4.5 and 5.0, would require removing 2 segments of Route 9991 or installing 4 stream crossing structures. Removing Route 9991 segments would be far more economical than installing 4 adequate stream crossing structures. (Figure 15).

Reactivating the lower meander at the bottom of Reach 4, between milepost 15 and 15.5, would involve channel work only and would not require

Summary of Opportunities Independent of Road Alignments

- Add floodplain benches to select segments
- Improve habitat with LWD placement and meander reactivation
- Reduce weeds, enhance riparian vegetation and stream shade
- Enhance wetlands, mitigate loss
- Improve, add and maintain road BMPs
- Remove contaminated road material
- Eliminate fish passage barriers
- Better manage wood cutting and dispersed recreation in riparian areas

road removal or installation of additional stream crossing structures. Reactivating the meander at milepost 15.5 would require removing at least 1 segment of Route 9991 or installing 2 stream crossing structures.

Reactivating the meander near the bottom of Reach 4, near milepost 16, would involve removing a segment of Route 9991 or installing 2 stream crossing structures (Figure 16).

Changes to the abandoned meander sequences in the lower third of Reach 9 could be accomplished with channel work only with without removing any road segments. However, removing Route 9991 in this vicinity would decrease road encroachment and, in combination with channel reactivation, would result in the greatest benefit to river and riparian resources (Figure 17).

Ensuring quality habitat throughout the mainstem of the Thompson River is important for providing migratory routes to tributaries where spawning and rearing occur. It may also be necessary to determine which reaches would benefit most from these improvements, and would therefore be most beneficial to native trout.

There is a widespread need to restore native vegetative communities to areas where weed infestations, or other non-native plants such as reed canary grass and agricultural forbs, have altered the native flora and likely affected wildlife and other organisms. An example of this includes efforts in the upper reaches of the Thompson River by Plum Creek Timber Company and Geum Consulting to revert agricultural grasses back to riparian meadow communities with willows, dogwood, and other shrubs.

Riparian community enhancement should focus on improving stream shading to address stream temperature, as well as improving tree-dominated riparian communities to increase large woody debris recruitment potential. LWD increases stream shade and improves habitat for future fisheries. Improved riparian habitat would also benefit terrestrial organisms.

Wetland enhancement opportunities also exist, many of which are in conjunction with other needs and opportunities.

Road BMPs need to be improved, implemented and/or maintained to address water quality and sediment-related impacts to the fishery. Regardless of which decision is selected, improvements should be made to reduce water quality impacts in the short-term. If a single route is selected and immediately implemented, the necessary BMP improvements and mitigation measures for the selected route could become a priority. Addressing long segments of both roads in Reach 1, as well as shorter segments in Reaches 3 (9991), 4 (both), 5 (both), 8 (9991), and 9 (56) would result in the greatest improvements over existing conditions. The most beneficial cross drain improvements could be made in Reaches 3, 4, 7, 8 (9991), 9 (56), and smaller improvements in Reaches 1, 2, 5, and 6.

Material from contaminated road segments should be removed and/or remediated. Further analysis of the contamination may be required to determine if it has migrated further than the 2'

examined for this analysis. A detailed remediation plan meeting state and federal requirements would likely need to be developed and implemented.

The stream crossings that are to remain in place should be upgraded with structures that can pass Q100 flows, debris, and provide a simulated stream environment to allow for aquatic organism passage. Upgrades will also reduce the amount of potential road fill at risk. The Chippy and Deerhorn crossings are currently under design and will be replaced with fish-passable, Q100 structures.

There is tremendous opportunity for strategic placement of LWD structures which would improve existing habitat conditions and mitigate habitat loss and degradation.

Management of wood cutting and dispersed recreation could be reviewed for ways to decrease impacts to the riparian area and to better promote establishment of riparian communities.

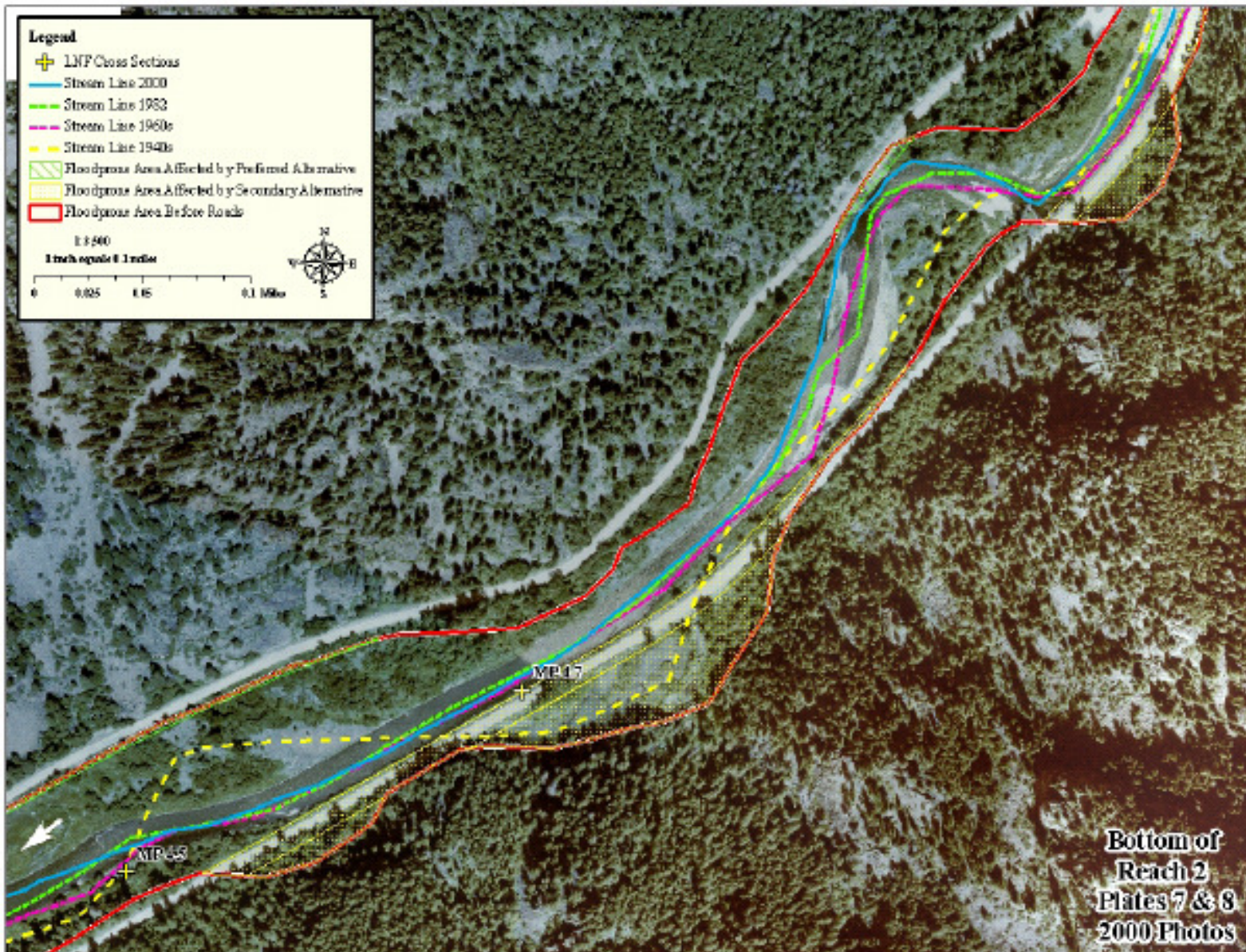


Figure 14. Channel changes and meander cut-offs in Reach 2 below the West Fork Thompson River. See also Figure 4 in Channel Morphology Analysis report.

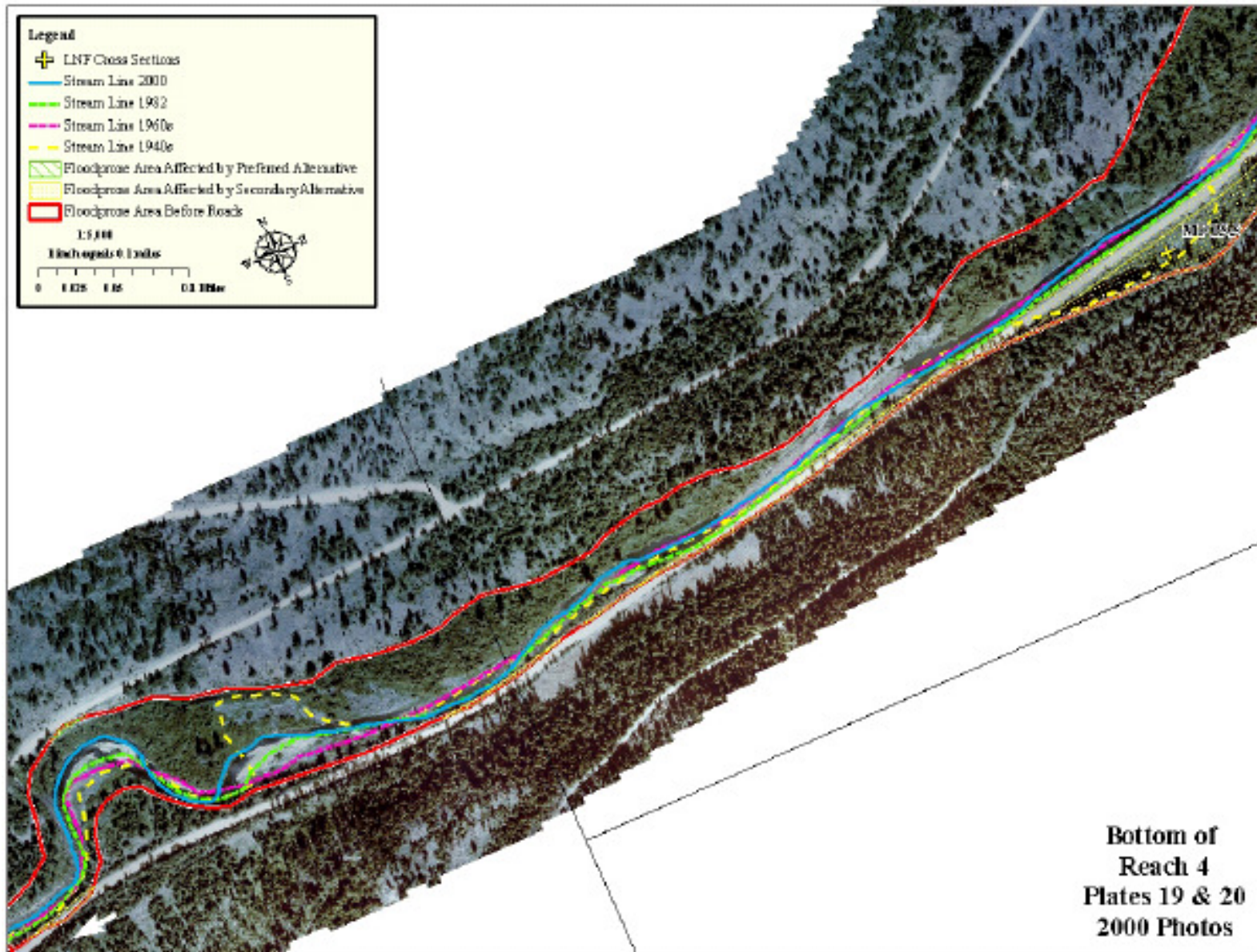


Figure 15. Channel changes over time in the lower portion of Reach 4.

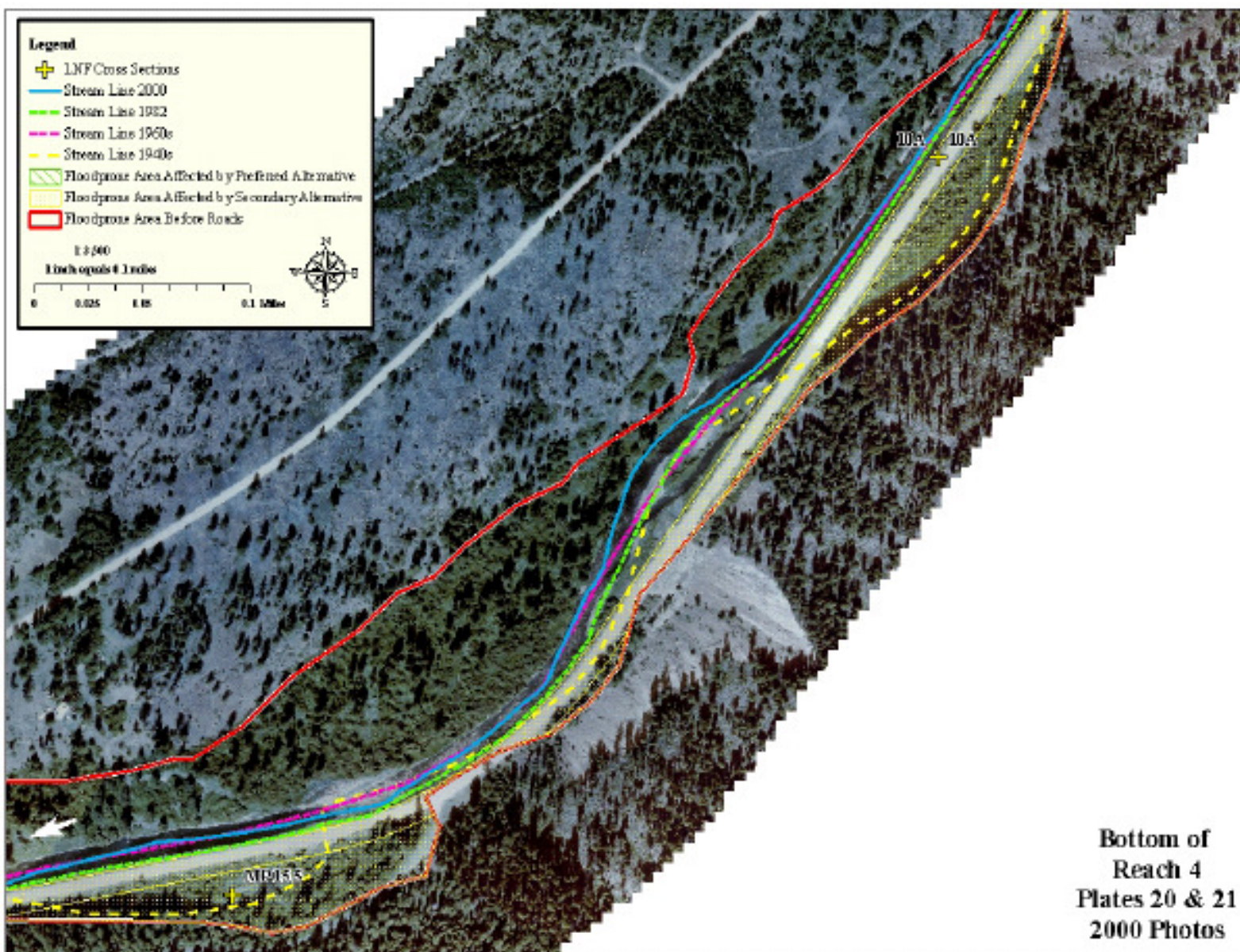


Figure 16. Channel changes and meander cut-offs over time in the lower portion of Reach 4.

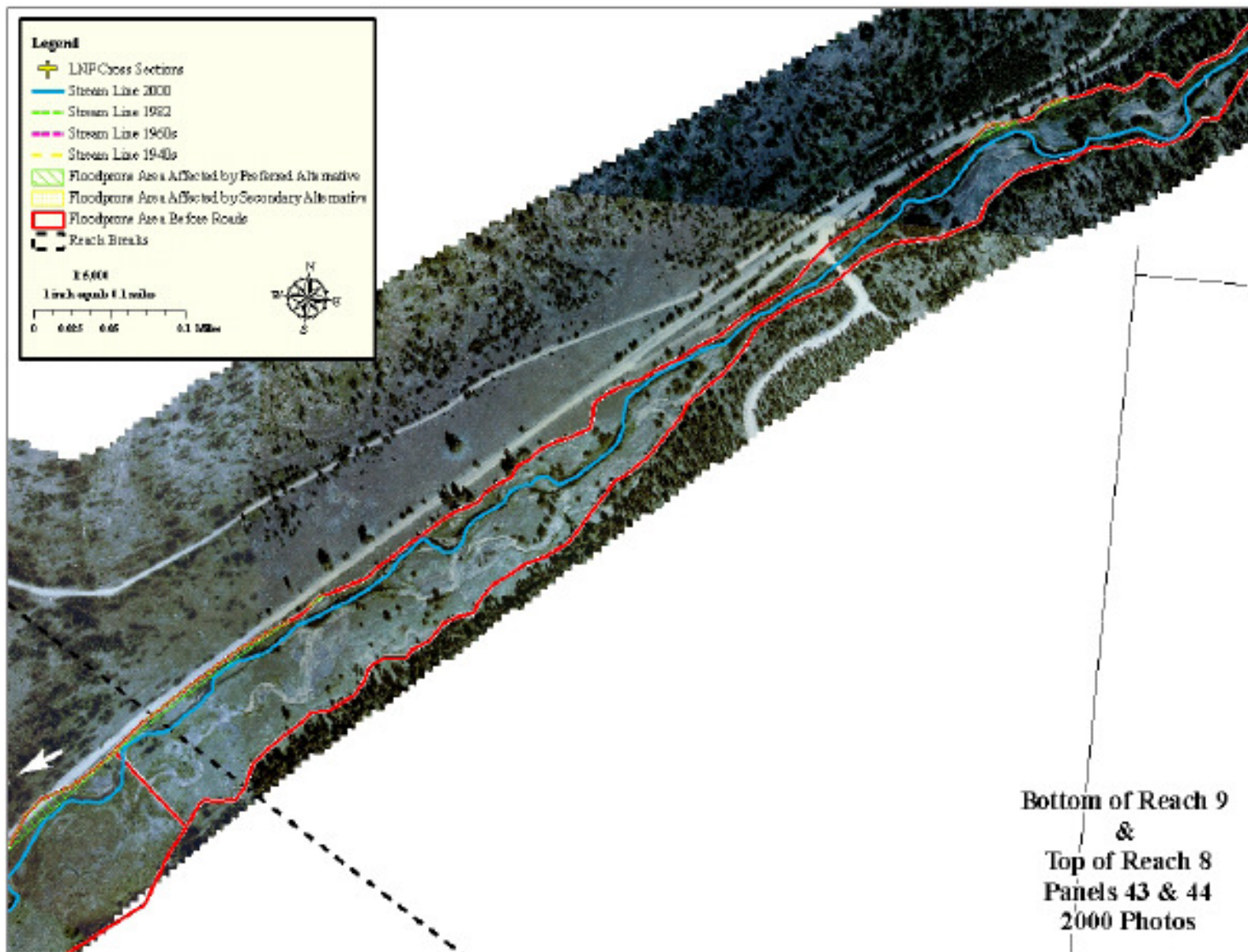


Figure 17. Stream channel alignment from the 2000 photo series. More sinuous historical channel location also apparent.

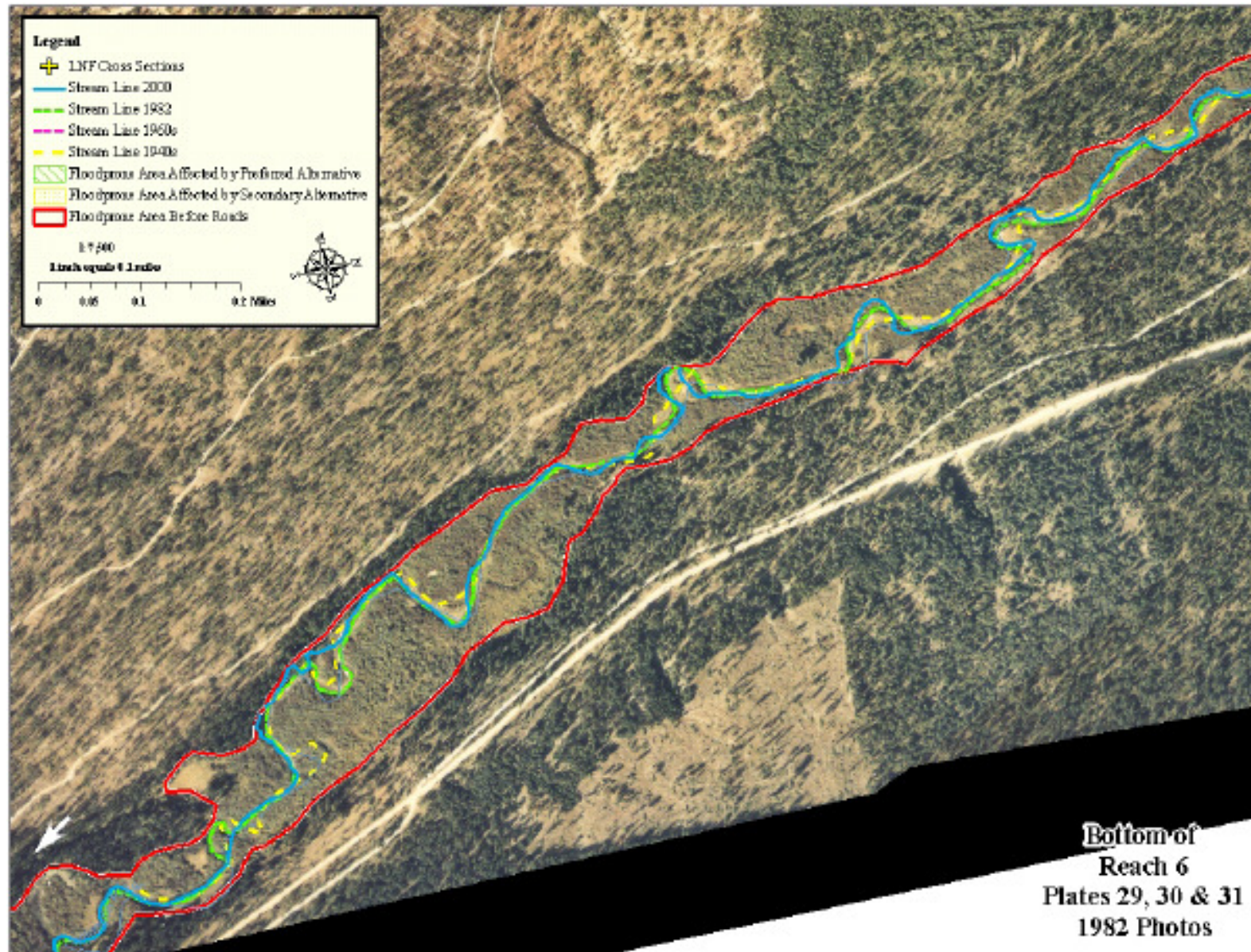


Figure 18. Changes in channel length (and sinuosity) in the lower portion of Reach 6; an example of natural channel function and meander development. Road impacts appear minimal.

Opportunities Related to a Single Selected Road Alignment

Road segments of the alignment not selected should be decommissioned fully where possible to provide for floodplain and/or wetland function if applicable, riparian community establishment if applicable, and overall watershed function. A plan for the type and method of decommissioning for each road segment with the potential to be decommissioned will likely require further site specific assessments. The plan should focus on removing the impeding road fill/road prism to create additional accessible floodplain for the Thompson River. The plan would specify which types of vegetation communities to be restored at each site, necessary weed treatments, and other vegetation treatments such as converting non-native assemblages to appropriate vegetative communities for each site.

Summary of Opportunities Related to a Single Road Alignment

- Remove fill of surplus road from floodplain, potential and former wetlands, and riparian areas
- Provide benefits to floodplain, riparian, hydrology, habitat and other resources by selecting the alignment farthest from the river
- Establish trail bridges to maintain access where surplus road segments are removed
- **The greatest benefits to all evaluated resources would be provided by a combination of the proposed alignments: the Preferred Alignment in Reaches 1 - 4 and the Secondary Alignment in Reaches 5 - 10 (Figure 19)**

The first three meander reactivation opportunities listed previously would be best accomplished along with the Preferred Alignment. The benefits of meander reactivation in Reach 9 would be best in combination with the Secondary Alignment for that reach.

Any decision resulting in the road being further from the river – thus, restoring hydrologic connectivity among the river, floodplain, wetlands in the floodplain, and adjacent uplands - will benefit the wetland and riparian resource. It is also important to note that some perched wetland areas may be lost if the roads currently supporting the wetlands by limiting drainage are removed. While loss of these perched wetlands may have regulatory ramifications, this would not necessarily be a negative result from the perspective of restoring ecological function and natural processes throughout the riverine system.

The most favorable alternative for large wood is one that results in roads being furthest from the river and maximizes reforestation of previously roaded areas within the large wood recruitment zone. In addition, alternative alignments that improve the river's connectivity to its floodplain will maximize natural processes resulting in large wood recruitment.

Removing road fill may provide this in some areas. In other areas, removing fill and/or reconnecting cutoff meanders may also help to enhance the wetlands resource.

As described in the wetland analysis report, jurisdictional wetlands would need to be delineated once a final alignment is selected.

As suggested by many interviewees in the creel survey, there is a need to provide several foot bridge access points from the selected route to the opposite side of the river to maintain

accessibility to both sides of the river. Access to the potentially “non-roaded” side could also be maintained by keeping trail access for hiking, fishing, camping, etc. Access to these trails could be provided at river crossings where the selected alignment crosses the Thompson River.

As previously described, and as presented in Table 10, the greatest benefit to the hydrologic and aquatic resources of the Thompson River would include a combination of the proposed alignments and decommissioning the remaining surplus segments. The combination would consist of the Preferred Alignment in Reaches 1-4 and the Secondary Alignment in Reaches 5-10 (Figure 19).